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The mildews of the cereals *

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In a recent paper[22] I have given a complete summary of the work that has been done on the physiological specialization of the Erysiphaceae. Since that paper was completed Salmon[29] has published some results with the hop mildew [*Sphaerotheca Humuli* (DC.) Burr.]. Salmon obtained ascospores from the hop and sowed them on the same plant, and also on *Potentilla reptans* and *Spiraea Ulmaria*, but infection occurred only on the hop. The conidia produced on the hop failed also to infect *Spiraea Ulmaria* although conidia similarly produced infected the hop.

Thus far one or more species of five genera of the Erysiphaceae have been tested with reference to their physiological specialization, namely, *Erysiphe*, *Microsphaera*, *Phyllactinia*, *Sphaerotheca*, and *Uncinula*. As yet no species of *Podosphaera* has been tested. The work with *Sphaerotheca*, *Microsphaera*, *Phyllactinia*, and *Uncinula* has been very limited, relatively few tests having been made with species of these genera. Practically all of the work of importance has been done with two species of *Erysiphe*, viz., *E. Cichoracearum* and *E. Graminis*.

Although from the morphological standpoint the same species of mildew, *Erysiphe Graminis*, attacks all grasses reported as hosts of the mildew, yet physiological differences have been found to exist between the mildews on the various grasses. Marchal[18] first pointed out the existence of *formes spéciales* in the grass mildew. He states that the mildew on each of the cereals (barley, oats,

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rye, and wheat) belongs to a separate specialized form. The mildew on wheat (*Triticum vulgare*) infected wheat and also *T. Spelta*, *T. polonicum*, and *T. turgidum*, but not *T. dicoccum*, *T. durum*, *T. monococcum*, barley, oats, or rye. The mildew on barley (*Hordeum vulgare*) infected barley and also *H. hexastichon*, *H. jubatum*, *H. murinum*, *H. nudum*, and *H. trifurcatum*, but not *H. bulbosum*, *H. maritimum*, *H. secalinum*, oats, rye, or wheat. The mildew on rye (*Secale cereale*) infected rye and *S. anatolicum*, but not the other cereals. The mildew on oats (*Avena sativa*) infected oats and also *A. fatua*, *A. orientalis*, and *Arrhenatherum elatius*, but not the other cereals.

Salmon has also done considerable work with the grass mildew, and while in general his results agree with those of Marchal, yet there are some interesting minor differences. For example, Salmon[24] was unable to infect *Arrhenatherum elatius* with the oat mildew. In the case of the barley mildew, Salmon[25] found that conidia from barley infected *Hordeum bulbosum*, *H. deficiens*, *H. distichon*, *H. hexastichon*, *H. intermedium*, *H. maritimum*, *H. vulgare*, and *H. Zeocriton*, but not *H. jubatum*, *H. murinum*, *H. secalinum*, or *H. silvaticum*.

My previous results[21] with the mildew on *Secale cereale* agree with those of Marchal. I was not able to infect barley, oats, wheat, and twelve other grasses, all of which have been reported as hosts of *Erysiphe Graminis*, while rye was readily infected with conidia from the same host.

During the past year I have carried out further extensive experiments with the mildews of barley, rye, and wheat. While at the University of Wisconsin, I had, as described in an earlier paper,[21] cultures of the rye and barley mildews growing in the botanical greenhouse. Through the kindness of Professor R. A. Harper, cultures of these mildews were forwarded to me at Columbia, Missouri. The wheat mildew was first found in the fall of 1907, at Columbia, on wheat plants brought into the greenhouse from the field for experimental work. In a few days after these plants were brought in, the mildew was observed to be present. The fungus spread very rapidly and cultures have been kept growing ever since.

I am indebted to a number of people for furnishing me with

the seed of the various cereals and grasses used in the following tests. The U. S. Department of Agriculture, at Washington, D. C., sent seed of *Triticum dicoccum* (Black Winter Emmer and White Emmer), *T. durum* (var. Kubanka), *T. polonicum*, *T. Spelta*, *Hordeum distichon*, *H. nudum*, *H. vulgare*, and *H. Zeocriton*. Vilmorin-Andrieux & Company furnished seed of *Hordeum trifurcatum*, *Triticum monococcum*, and *T. turgidum*. From the California Agricultural Experiment Station I received seed of *Hordeum distichon*, *H. tetrastichon*, *Triticum dicoccum* (Black Emmer), *T. durum* (varieties Black Don, Chilean, and Kubanka), and *T. Spelta*. Haage & Schmidt, Erfurt, Germany, furnished seed of a number of plants, among others *Hordeum trifurcatum*, *Triticum monococcum*, and *T. turgidum*. Professor Trelease, of the Missouri Botanical Garden, sent me seed of *Triticum durum affine*, *T. compactum creticum*, and *T. monococcum*. Professor C. A. Zavitz, of the Ontario Agricultural College, sent seed of *Triticum dicoccum* (Red Emmer, Russian Emmer, Common Emmer, and Black Winter Emmer), and *T. durum* (Medeah Spring Wheat, Soretina Spring Wheat, and Wild Goose Spring Wheat). I am especially indebted to Professor Doctor Fr. Bubák, Director of the Botanical Garden at Tábor, Bohemia, for seed of *Triticum Freycenetii*, *T. monococcum* (varieties *Hornemannii* and *vulgare*), *T. Spelta*, *T. Thaoudar*, *T. Tumonia*, *T. turgidum*, *Secale dalmaticum*, *S. montanum*, *S. cereale* × *Triticum vulgare*, *Hordeum maritimum*, and *H. Steudelii* × *H. trifurcatum*.

According to Hackel[15] there are only three distinct species of *Triticum* in cultivation. Hackel classifies the cultivated wheats as follows:

- *Triticum*
  - *monococcum* L., Einkorn.
  - *sativum*
    - *dicoccum* Schrank, Emmer.
    - *Spelta* Hackel, Spelt.
    - *tenax*
      - *vulgare* Hackel, Wheat.
      - *compactum* Hackel, Club Wheat.
      - *turgidum* Hackel, Poulard Wheat.
      - *durum* Hackel, Durum Wheat.
  - *polonicum* L. Polish Wheat.

Hackel classifies the commonly cultivated barleys as follows: *Hordeum sativum distichon* Hackel, including several varieties, as *erectum*, *nutans*, *Zeocriton*, *macrolepis*, *deficiens*, and *nudum*; *H.*

sativum hexastichon Hackel; and *H. sativum vulgare* Hackel, including *H. coeleste*, *H. intermedium*, *H. Kaufmanni*, and *H. trifurcatum*.

TABLE I.—RESULTS WITH *Avena sativa* L.

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1908					1908		
38c	Jan. 2	*Hordeum distichon*	8	3	3	Jan. 11	—	—
77b	Feb. 10	" "	9	3	2	Feb. 17	—	—
79c	" 10	" "	9	2	3	" 17	—	—
80c	" 10	" "	9	3	3	" 17	—	—
86c	" 22	" "	9	5	6	" 29	—	—
	1907					1907		
13a	Dec. 24	*Hordeum vulgare*	8	3	3	Dec. 30	—	—
						1908		
21b	" 31	" "	10	2	3	Jan. 7	—	—
23b	" 31	" "	10	4	2	" 7	—	—
24b	" 31	" "	10	3	3	" 7	—	—
25c	" 31	" "	10	3	4	" 7	—	—
	1908							
36b	Jan. 2	" "	8	3	1	" 11	—	—
44b	" 18	" "	14	3	3	" 24	—[1]	—
45b	" 18	" "	14	3	2	" 24	—[1]	—
65c	Feb. 3	" "	10	3	2	Feb. 10	—	—
66c	" 3	" "	10	3	3	" 10	—	—
67a	" 3	" "	10	2	3	" 10	—	—
147a	Oct. 31	" "	9	3	1	Nov. 7	—	—
147c	" 31	" "	9	2	1	" 7	—	—
98b	Mar. 3	*Hordeum Zeocriton*	7	2	2	Mar. 10	—	—
99b	" 3	" "	7	3	4	" 10	—	—
100b	" 3	" "	7	2	4	" 10	—	—
101a	" 3	" "	7	2	4	" 10	—	—
58a	Feb. 1	*Triticum durum*	8	3	3	Feb. 10	—	—
93b	" 22	*Triticum polonicum*	9	5	6	" 29	—	—
94c	Mar. 3	*Triticum Spelta*	7	3	5	Mar. 10	—	—
95c	" 3	" "	7	4	2	" 10	—	—
	1907					1907		
16c	Dec. 25	*Triticum vulgare*	9	3	5	Dec. 30	—	—
18a	" 25	" "	9	2	4	" 30	—	—
						1908		
26b	" 31	" "	10	4	2	Jan. 7	—	—
27b	" 31	" "	10	3	3	" 7	—	—
	1908							
32a	Jan. 2	" "	8	3	5	" 11	—	—
42a	" 17	" "	13	3	4	" 24	—	—
62a	Feb. 3	" "	10	3	3	Feb. 10	—	—
76a	" 10	" "	9	3	2	" 17	—	—
90a	" 22	" "	9	5	6	" 29	—	—
92c	" 22	" "	9	4	4	" 29	—	—

[1] Discolored areas were visible on the inoculated leaves, indicating the beginning of infection. No well-developed mycelium producing conidia appeared, however These were the only plants in which any evidence of infection was obtained.

TABLE II.— RESULTS WITH *Hordeum bulbosum* L.

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. p'ants	Controls
	1908					1908		
132b	Oct. 21	*Hordeum vulgare*	8	4	2	Oct. 30	—	—
133b	" 21	" "	8	4	1	" 30	—	—
137b	" 31	" "	9	1	0	Nov. 7	—	. . .
138c	" 31	" "	18	3[1]	1	" 7	—	—
151a	Nov. 10	" "	19	1[2]	1	" 19	—	—
153b	" 10	" "	19	2[1]	0	" 19	—	. . .
163c	" 16	" "	13	1	0	" 26	—	. . .
164a	" 16	" "	13	2	1	" 26	+[3]	—
176c	" 27	" "	13	1[2]	1	Dec. 5	—	—
178b	" 27	" "	13	2[2]	2	" 5	—	—
179c	" 27	" "	13	1	0	" 5	—	. . .
181a	" 27	" "	24	2[2]	2	" 5	—	—

[1] The second leaf inoculated.

[2] Two leaves inoculated.

[3] A few small tufts of conidia appeared on one inoculated leaf.

In the tables given herewith, I have deemed it best to follow the older classification of Linnaeus, as the various cultivated varieties of wheat and barley are commonly referred to in this way. I have, however, indicated the position of the forms tested in Hackel's classification.

The plants used in the experiments were grown in two and one-half inch flower pots. In each pot some of the plants were inoculated, while the remaining ones were kept as controls. Generally the spores were sown on the first green leaf. After the plants were inoculated, the pots were placed under a tall bell-jar, usually three pots being placed under the same jar. The bell-jars were slightly raised at the base to allow a free circulation of air. The pots were placed in a saucer, and water, when needed, was poured into the latter.

The plants were inoculated by transferring with a scalpel conidia from an infected plant and spreading them over the surface of the leaf of the plant that was to be inoculated. In order to be sure of plenty of conidia, I found it advantageous to place infected plants under a bell-jar for a day or two before inoculation. In this way the conidia were formed in abundance and remained upon the leaves instead of being scattered by currents of air. Thus I

TABLE III. — RESULTS WITH *Hordeum distichon* L.[1]

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
5b	1907 Dec. 16	*Hordeum distichon*	9	3	4	1907 Dec. 23	+ + +	—
78b	1908 Feb. 10	" "	9	3	4	1908 Feb. 17	+ + +	—
79b	" 10	" "	9	4	2	" 17	+ + +	—
80a	" 10	" "	9	4	1	" 17	+ + +	—
86a	" 22	" "	9	5	6	" 29	+ + +	—
88a	" 22	" "	9	4	2	" 29	+ + +	—
85b	" 21	*Hordeum nudum*	8	5	5	" 29	+ + +	—
1a	1907 Dec. 9	*Hordeum vulgare*	8	3	3	1907 Dec. 16	+ + +	—
3a	" 9	" "	8	3	2	" 16	+ + +	—
4c	" 9	" "	8	2	3	" 16	+ + +	—
8c	" 16	" "	9	3	2	" 23	+ + +	—
9c	" 16	" "	9	1	1	" 23	+ + +	—
12a	" 24	" "	8	4	4	" 30	+ + +	—
15c	" 25	" "	9	3	2	" 30	+ + +	—
34b	1908 Jan. 2	" "	8	2	2	1908 Jan. 11	+ + +	—
35b	" 2	" "	8	2	3	" 11	+ + +	—
36c	" 2	" "	8	2	2	" 11	+ + +	—
44c	" 18	" "	14	3[2]	1	" 24	+ + +	—
45a	" 18	" "	14	2[2]	3	" 24	+ + +	—
46c	" 18	" "	14	4[2]	4	" 24	+ + +	—
64b	Feb. 3	" "	10	1	2	Feb. 10	+ + +	—
65b	" 3	" "	10	2	2	" 10	+ + +	—
67c	" 3	" "	10	3	3	" 10	+ + +	—
133a	Oct. 21	" "	8	2	1	Oct. 30	+ + +	—
6c	1907 Dec. 16	*Hordeum Zeocriton*	9	3	3	1907 Dec. 23	+ + +	—
17b	" 25	*Triticum vulgare*	9	2	3	" 30	—	—
33a	1908 Jan. 2	" "	8	3	2	1908 Jan. 11	—	—

[1] *Hordeum sativum distichon* Hackel.

[2] The second leaf of each plant inoculated.

TABLE IV.—RESULTS WITH *Hordeum jubatum* L.

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
133c	1908 Oct. 21	*Hordeum vulgare*	8	8	4	1908 Oct. 30	—	—
135c	" 23	" "	10	3	3	" 31	—	—
163a	Nov. 16	" "	13	3	1	Nov. 26	—	—
175b	" 27	" "	13	1	0	Dec. 5	—	...
180a	" 27	" "	13	1	1	" 5	—	—
181b	" 27	" "	24	1[1]	1	" 5	—	—

[1] Two leaves of the plant inoculated.

was always sure of a large quantity of good, viable conidia. In most experiments plants of the same species as that from which the mildew was obtained were inoculated. If the mildew developed upon these plants, it was considered sufficient evidence that the conidia were entirely viable.

TABLE V. — RESULTS WITH *Hordeum maritimum* With.

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1908					1908		
120b	July 28	*Hordeum vulgare*	4	2	1	Aug. 5	—	—
121c	" 28	" "	4	3	1	" 5	—	—
130c	Oct. 19	" "	6	5	2	Oct. 26	—	—
131c	" 19	" "	6	5	3	" 26	—	—
137c	" 31	" "	9	4	3	Nov. 7	—	—
138b	" 31	" "	9	3	1	" 7	—	—
152c	Nov. 10	" "	7	7	2	" 19	—	—
153a	" 10	" "	7	8	2	" 19	—	—
173a	" 20	" "	6	8	6	" 26	—	—
174c	" 20	" "	6	7	3	" 26	—	—
176b	" 27	" "	13	3[1]	5	Dec. 5	—	—
177c	" 27	" "	13	3[1]	3	" 5	—	—

[1] Two leaves of each plant inoculated.

TABLE VI.— RESULTS WITH *Hordeum nodosum* L.[1]

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1908					1908		
112c	July 10	*Hordeum vulgare*	20	2	0	July 18	+++	...
116b	" 18	" "	28	3[2]	0	" 28	++	...
132c	Oct. 21	" "	8	7	10	Oct. 30	+++	—
135b	" 23	" "	10	7	8	" 31	+++	—
151c	Nov. 10	" "	19	3	1	Nov. 19	—[3]	—
152a	" 10	" "	19	2[4]	4	" 19	—[3]	—
163b	" 16	" "	13	6	5	" 26	+++	—
164c	" 16	" "	13	10	6	" 26	+++	—
175a	" 27	" "	13	5	3	Dec. 5	++	—
177b	" 27	" "	13	4	6	" 5	+++	—
178c	" 27	" "	13	4	6	" 5	+++	—
179b	" 27	" "	13	5	2	" 5	+++	—
181c	" 27	" "	24	6[4]	6	" 5	—	—

[1] *Hordeum pratense* Huds.= *H. secalinum* Schreb.

[2] The first leaf of one plant and the second and third leaves of the other two plants were inoculated. Infection occurred on the first leaf of the one plant.

[3] The tips of the inoculated leaves had withered and turned yellow.

[4] Two leaves inoculated.

TABLE VII.—RESULTS WITH *Hordeum nudum* L.[1]

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
5a	1907 Dec. 16	*Hordeum distichon*	9	2	2	1907 Dec. 23	+++	—
38a	1908 Jan. 2	" "	8	2	2	1908 Jan. 11	+++	+[2]
78a	Feb. 10	" "	9	3	1	Feb. 17	+++	—
80b	" 10	" "	9	3	3	" 17	+++	—
86b	" 22	" "	9	3	3	" 29	+++	—
87b	" 22	" "	9	1	3	" 29	+++	—
7a	1907 Dec. 16	*Hordeum nudum*	9	2	1	1907 Dec. 23	+++	—
85a	1908 Feb. 21	" "	8	4	2	1908 Feb. 29	+++	—
1b	1907 Dec. 9	*Hordeum vulgare*	8	3	4	1907 Dec. 16	+++	—
2c	" 9	" "	8	3	3	" 16	+++	—
4a	" 9	" "	8	2	3	" 16	+++	—
8b	" 16	" "	9	2	2	" 23	+++	—
9a	" 16	" "	9	2	1	" 23	+++	—
35c	1908 Jan. 2	" "	8	3	2	1908 Jan. 11	+++	+[2]
37c	" 2	" "	8	4	3	" 11	+++	—
45c	" 18	" "	14	3	3	" 24	+++	—
48c	" 18	" "	14	1	2	" 24	+++	—
67b	Feb. 3	" "	10	1	2	Feb. 10	+++	—
68a	" 3	" "	10	1	0	" 10	+++	.....
61b	" 1	*Triticum polonicum*	7	1	1	" 10	—	—
43c	Jan. 17	*Triticum vulgare*	13	2	3	Jan. 24	—	+[2]

[1] Hackel considers this a variety of *Hordeum sativum distichon*.

[2] A small patch of mycelium bearing conidia on one leaf of a control.

TABLE VIII. — RESULTS WITH *Hordeum Steudelii* ♀ × *H. trifurcatum* ♂

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
120a	1908 July 28	*Hordeum vulgare*	4	3	1	1908 Aug. 5	+++	—
121b	" 28	" "	4	3	2	" 5	+++	—
131b	Oct. 19	" "	6	3	3	Oct. 26	+++	—
172b	Nov. 20	" "	6	2	1	Nov. 26	+++	—
173c	" 20	" "	6	2	3	" 26	+++	—
174b	" 20	" "	6	3	3	" 26	+++	—
177a	" 27	" "	6	4	3	Dec. 5	+++	—
179a	" 27	" "	6	3	2	" 5	+++	—
180c	" 27	" "	6	3	1	" 5	+++	—

TABLE IX.— RESULTS WITH *Hordeum tetrastichon* L.[1]

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1908					1908		
130b	Oct. 19	*Hordeum vulgare*	6	3	2	Oct. 26	+++	—
172a	Nov. 20	" "	6	3	2	Nov. 26	+++	—
173b	" 20	" "	6	3	6	" 26	+++	—
174a	" 20	" "	6	2	1	" 26	+++	—
175c	" 27	" "	6	3	4	Dec. 5	+++	—
178a	" 27	" "	6	5	4	" 5	+++	—
180b	" 27	" "	6	7	2	" 5	+++	—

[1] Variety *trifurcatum* Schl. used.

TABLE X.— RESULTS WITH *Hordeum trifurcatum* Jacq.[1]

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1908					1908		
115a	July 14	*Hordeum vulgare*	4	4	2	July 22	+++	—
115b	" 14	" "	4	3	3	" 22	+++	—
119b	" 23	" "	6	3	1	" 29	+++	—
151b	Nov. 10	" "	7	1	0	Nov. 19	+++	....
164b	" 16	" "	13	2[2]	1	" 26	+++	—

[1] Considered by Hackel to be a form of *Hordeum sativum vulgare*.

[2] Two leaves of each plant inoculated.

The infection, if it occurred, was observed in three to five days after inoculation. A number of observations were made, but only the final one is recorded.

In the accompanying tables I have brought together the results of the tests. I have indicated a full, vigorous growth of mildew by three plus signs, a good infection by two plus signs, a slight infection by one plus sign, and no infection by the minus sign.

For the purpose of direct comparison, I have brought together in TABLE XXVIII all of the results given with these twenty-seven different grasses. I have also included my[21] own previous results with the grass mildew and also the results obtained by Marchal[18] and Salmon[24, 25, 27].

Marchal does not give the data upon which his conclusions are based. It is impossible to tell whether he sowed spores from

TABLE XI.—RESULTS WITH *Hordeum vulgare* L.[1]

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
5c	1907 Dec. 16	*Hordeum distichon*	9	3	2	1907 Dec. 23	+++	—
38b	1908 Jan. 2	" "	9	3	4	1908 Jan. 11	+++	—
77a	Feb. 10	" "	9	4	4	Feb. 17	+++	—
192a	Nov. 30	*Hordeum nodosum*	9	1	2	Dec. 5	+++	—
7c	1907 Dec. 16	*Hordeum nudum*	9	4	3	1907 Dec. 23	+++	+[2]
1c	" 9	*Hordeum vulgare*	8	4	4	" 16	+++	—
2b	" 9	" "	8	3	3	" 16	+++	—
3b	" 9	" "	8	2	2	" 16	+++	—
9d	" 16	" "	9	4	3	" 23	+++	—
10a	" 24	" "	10	2	4	" 30	+++	—
11b	" 24	" "	10	4	2	" 30	+++	—
12b	" 24	" "	10	3	3	" 30	+++	—
13c	" 24	" "	10	4	4	" 30	+++	—
14b	" 25	" "	9	4	3	" 30	+++	—
14c	" 25	" "	9	3	3	" 30	+++	—
15a	" 25	" "	11	3	2	" 30	+++	—
20b	" 31	" "	10	3	3	1908 Jan. 7	+++	—
22c	" 31	" "	10	3	2	" 7	+++	—
24c	" 31	" "	10	2	3	" 7	+++	—
25b	" 31	" "	10	3	2	" 7	+++	—
37b	1908 Jan. 2	" "	8	2	3	" 11	+++	+[2]
44a	" 18	" "	14	2	3	" 24	+++	—
46b	" 18	" "	14	1	1	" 24	+++	—
47b	" 18	" "	14	1	2	" 24	+++	—
64a	Feb. 3	" "	10	2	3	Feb. 10	+++	—
66a	" 3	" "	10	2	1	" 10	+++	—
111c	July 10	" "	7	5	5	July 18	+++	—
112a	" 10	" "	7	2	5	" 18	+++	—
115c	" 14	" "	4	4	3	" 22	+++	—
116a	" 18	" "	8	2[3]	2	" 28	+++	—
119a	" 23	" "	6	4	3	" 29	+++	—
120c	" 28	" "	4	4	2	Aug. 5	+++	—
121a	" 28	" "	4	5	3	" 5	+++	—
130a	Oct. 19	" "	6	3	3	Oct. 26	+++	+[2]
131a	" 19	" "	6	4	2	" 26	+++	—
132a	" 21	" "	8	3	1	" 30	+++	—
135a	" 23	" "	4	3	6	" 31	+++	—
137a	" 31	" "	9	2	1	Nov. 7	+++	—
138a	" 31	" "	9	3	1	" 7	+++	—
147b	" 31	" "	9	2	2	" 7	+++	—
152b	Nov. 10	" "	7	5	3	" 19	+++	—
153c	" 10	" "	7	4	3	" 19	+++	—
172c	" 20	" "	6	4	2	" 26	+++	—
176a	" 27	" "	6	6	7	Dec. 5	+++	—
6b	1907 Dec. 16	*Hordeum Zeocriton*	9	3	3	1907 Dec. 23	+++	—
98c	1908 Mar. 3	" "	7	3	2	1908 Mar. 10	+++	—

TABLE XI.—RESULTS WITH *Hordeum vulgare* L.[1]—*Continued*

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1908					1908		
99c	Mar. 3	*Hordeum Zeocriton*	7	2	1	Mar. 10	+++	—
100c	" 3	" "	7	2	1	" 10	+++	—
101c	" 3	" "	7	3	3	" 10	+++	—
39c	Jan. 17	*Triticum dicoccum*	13	3	2	Jan. 24	—	—
40c	" 17	" "	13	2	3	" 24	—	—
59b	Feb. 1	*Triticum durum*	8	2	3	Feb. 10	—	—
60a	" 1	*Triticum polonicum*	8	2	2	" 10	—	—
94a	Mar. 3	*Triticum Spelta*	7	1	1	Mar. 10	—	—
	1907					1907		
16b	Dec. 25	*Triticum vulgare*	11	2	2	Dec. 30	—	—
18c	" 25	" "	11	4	4	" 30	—	—
19c	" 25	" "	9	2	3	" 30	—	—
						1908		
27a	" 31	" "	10	3	3	Jan. 7	—	—
28a	" 31	" "	10	4	3	" 7	—	—
29c	" 31	" "	6	3	4	" 7	—	—
	1908							
30c	Jan. 2	" "	8	4	2	" 11	—	—
32b	" 2	" "	8	3	2	" 11	—	—
33b	" 2	" "	8	3	2	" 11	—	—
41c	" 17	" "	13	2	3	" 24	—	—
63c	Feb. 3	" "	10	1	1	Feb. 10	—	—
75a	" 10	" "	9	4	3	" 17	—	+[2]
96c	Mar. 3	" "	7	2	4	Mar. 10	—	—

[1] *Hordeum sativum vulgare* Hackel.

[2] A small infected area appeared on one control.

[3] The second green leaf of each plant inoculated.

each of the cereals on the various grasses. Consequently I have merely indicated whether his results are negative or positive. I have indicated his results simply on the basis of his seven *formes spéciales.*

In this table the first figure indicates the number of tests, the second figure the number of plants or leaves inoculated, and the third figure the number that became infected.

It is plain, from a consideration of TABLE I, and also the general summary, that the oat (*Avena sativa*) is immune to the barley, rye, and wheat mildews. In no case did complete infection follow where conidia were used from any of these three cereals. If, however, conidia are taken from *A. sativa* and sown upon the same plant, full infection follows, as shown by both Marchal's and Salmon's results.

TABLE XII.— RESULTS WITH *Hordeum Zeocriton* L.[1]

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
77c	1908 Feb. 10	*Hordeum distichon*	9	4	3	1908 Feb. 17	+ + +	—
79a	" 10	" "	9	4	2	" 17	+ + +	—
87a	" 22	" "	9	3	2	" 29	+ + +	—
88c	" 22	" "	9	5	3	" 29	+ + +	—
7b	1907 Dec. 16	*Hordeum nudum*	9	3	5	1907 Dec. 23	+ + +	—
85c	1908 Feb. 21	" "	8	4	5	1908 Feb. 29	+ + +	—
2a	1907 Dec. 9	*Hordeum vulgare*	8	2	4	1907 Dec. 16	+ + +	—
3c	" 9	" "	8	4	4	" 16	+ + +	—
4b	" 9	" "	8	2	4	" 16	+ + +	—
8a	" 16	" "	9	3	3	" 23	+ + +	+[2]
9b	" 16	" "	9	2	2	" 23	+ + +	—
20c	" 31	" "	10	3	2	1908 Jan. 7	+ + +	—
21a	" 31	" "	10	3	2	" 7	+ + +	—
22a	" 31	" "	10	2	2	" 7	+ + +	—
23a	" 31	" "	10	2	2	" 7	+ + +	—
24a	" 31	" "	10	2	2	" 7	+ + +	—
25a	" 31	" "	10	3	3	" 7	+ + +	—
47a	1908 Jan. 18	" "	14	3	3	" 24	+ + +	+[2]
48b	" 18	" "	14	2[3]	3	" 24	+ + +	—
65a	Feb. 3	" "	10	2	1	Feb. 10	+ + +	—
68b	" 3	" "	10	1	1	" 10	+ + +	—
68c	" 3	" "	10	1	2	" 10	+ + +	—
6a	1907 Dec. 16	*Hordeum Zeocriton*	9	3	2	1907 Dec. 23	+ + +	—
42b	1908 Jan. 17	*Triticum vulgare*	13	3[3]	3	1908 Jan. 24	—	—

[1] Considered by Hackel to be a form of *Hordeum sativum distichon*.

[2] A small infected area on two of the control plants.

[3] The second green leaf of each plant inoculated.

It is to be noted that in two of my experiments (44*b* and 45*b*, TABLE I), the leaves inoculated with barley mildew showed marked discolored areas. These areas were observed closely from time to time. There was strong evidence of an incipient infection, but the fungus failed to reach a full development. It is interesting in this connection to recall some of Salmon's[28] experiments. Salmon has studied the stages of development reached by the mildew from wheat when sown on barley, a plant which the wheat mildew cannot fully infect. He has found that the conidia germinate and form tubes which develop haustoria. There was, however, no marked development of the mycelium.

TABLE XIII. — RESULTS WITH *Secale cereale* L.

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1908					1908		
78c	Feb. 10	*Hordeum distichon*	9	3	1	Feb. 17	—	—
87c	Feb. 22	" "	9	2	3	" 29	—	—
88b	" 22	" "	9	2	3	" 29	—	—
	1907					1907		
13b	Dec. 24	*Hordeum vulgare*	8	3	1	Dec. 30	—	—
	1908					1908		
21c	" 31	" "	10	2	1	Jan. 7	—	—
23c	" 31	" "	10	3	3	" 7	—	—
	1908							
34c	Jan. 2	" "	8	2	2	" 11	—	—
35a	" 2	" "	8	3	1	" 11	—	—
46a	" 18	" "	14	1	2	" 24	—	—
48a	" 18	" "	14	2	2	" 24	—	—
66b	Feb. 3	" "	10	1	1	Feb. 10	—	—
136a	Oct. 23	*Secale cereale*	4	2	1	Oct. 31	+++	—
158c	Nov. 10	" "	7	4	1	Nov. 19	+++	—
159a	" 10	" "	7	1	0	" 19	+++	...
170c	" 20	" "	17	2[1]	2	" 26	+++	—
171c	" 20	" "	6	3	1	" 26	+++	—
187c	" 27	" "	6	1	0	Dec. 5	+++	...
83a	Feb. 21	*Triticum durum*	8	3	2	Feb. 29	—	—
	1907					1907		
17a	Dec. 25	*Triticum vulgare*	9	3	2	Dec. 30	—	—
19a	" 25	" "	9	2	3	" 30	—	—
	1908					1908		
26c	" 31	" "	10	3	1	Jan. 7	—	—
28b	" 31	" "	10	2	1	" 7	—	—
29a	" 31	" "	10	3	2	" 7	—	—
	1908							
31a	Jan. 2	" "	8	2	2	Jan. 11	—	—
41b	" 17	" "	13	2	1	" 24	—	—
76b	Feb. 10	" "	9	2	1	Feb. 17	—	—
91c	" 22	" "	9	3	2	" 29	—	—

[1] The first leaf of one plant and the second leaf of the other inoculated.

TABLE XIV. — RESULTS WITH *Secale dalmaticum* Vis.

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. Plants	Controls
	1908					1908		
158b	Nov. 10	*Secale cereale*	7	1	0	Nov. 19	—	....
171b	" 20	" "	17	1[1]	0	" 26	—	....
186a	" 27	" "	24	1[2]	0	Dec. 5	—	....

[1] The first and second leaves inoculated.

[2] The second and third leaves inoculated.

TABLE XV. — RESULTS WITH *Secale montanum* Guss.

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1908					1908		
146c	Oct. 31	*Secale cereale*	12	1	0	Nov. 7	—	.....
159b	Nov. 10	" "	22	1[1]	1	" 19	—	—
170a	" 20	" "	17	2[2]	1	" 26	—	—
186b	" 27	" "	13	1[2]	0	Dec. 5	+++	.....
187a	" 27	" "	24	2[2]	2	" 5	—	—
199a	Dec. 14	" "	23	3	0	" 23	—	.....
199b	" 14	" "	30	1	0	" 23	+++	.....
199c	" 14	" "	23	1	0	" 23	+++	.....

[1] The first and third leaves inoculated.

[2] Two leaves of each plant inoculated.

Out of the eleven species of *Hordeum* tested with the barley mildew, seven (*Hordeum distichon*, *H. nudum*, *H. Steudelii* × *H. trifurcatum*, *H. tetrastichon*, *H. trifurcatum*, *H. vulgare*, and *H. Zeocriton*) proved perfectly susceptible. Infection occurred on every plant that was inoculated.

One species (*Hordeum nodosum*) gave a very large percentage of infection, fifty-one plants out of the sixty-four inoculated becoming infected. According to the Index Kewensis, this species is the same as *Hordeum secalinum* Schreb. Salmon[25] claims that *H. secalinum* is entirely immune to the barley mildew. I am uncertain whether Salmon was working with *H. secalinum* Schreb. or whether he had some other species of *Hordeum* listed under this specific name. It is clear from my results that young plants of *Hordeum nodosum* are quite susceptible to the barley mildew. Older plants, however, appear to be immune, for in every case where the second green leaf was inoculated, no infection occurred.

When plants of *Hordeum bulbosum* were inoculated with conidia from barley, only one leaf out of the twenty-four inoculated became infected. It is interesting to note that Salmon secured only one positive result out of fourteen inoculated plants, and Marchal reported the results with this plant as negative, when conidia from barley were used. This species evidently is practically immune to the barley mildew.

In my experiments I was unable to infect *Hordeum jubatum*

with the barley mildew. This result is in harmony with the work of Salmon. Marchal, however, states that *H. jubatum* can be infected with conidia from the barley.

My results with *Hordeum maritimum* agree with Marchal's. I was unable to obtain any infection if conidia from barley were

TABLE XVI.—RESULTS WITH *Secale cereale* L. × *Triticum vulgare* Vill.[1]

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1908					1908		
127d	Oct. 19	*Secale cereale*	6	1	1[2]	Oct. 26	—	—
136b	" 23	" "	4	1	0	" 31	—	.....
146a	" 31	" "	12	1[3]	0	Nov. 7	+[4]	.....
146b	" 31	" "	12	1[3]	0	" 7	+[4]	.....
158a	Nov. 10	" "	7	1	0	" 19	+[4]	.....
162d	" 12	" "	9	1	1[2]	" 21	++[5]	—
170b	" 20	" "	6	1	0	" 26	—	.....
171a	" 20	" "	17	2[6]	1	" 26	++	—
186c	" 27	" "	13	2	0	Dec. 5	++[7]	.....
187b	" 27	" "	13	1[8]	0	" 5	++[9]	.....
196b	Dec. 14	" "	30	2[10]	0	" 23	—	.....
197b	" 14	" "	30	2	0	" 23	++[11]	.....
198b	" 14	" "	30	2	0	" 23	—	.....
122c	July 28	*Triticum vulgare*	4	2	1	Aug. 5	—	—
126a	" 28	" "	4	2	1	" 5	—	—
127c	Oct. 19	" "	6	1	1	Oct. 26	—	—
145c	" 31	" "	18	1[12]	1	Nov. 7	—	—
162c	Nov. 12	" "	9	1	1	" 21	—	—
168b	" 20	" "	6	2	0	" 26	+[13]	.....
185b	" 26	" "	12	1[8]	0	Dec. 5	—	.....
196a	Dec. 14	" "	30	2	0	" 23	—	.....
197a	" 14	" "	30	2	0	" 23	—	.....
198a	" 14	" "	30	2	0	" 23	—	.....

[1] The seed for these experiments was obtained from Professor Bubák, Director of the Botanical Garden, Tábor, Bohemia.

[2] The control plant was inoculated with conidia from wheat but no infection occurred. (See exp. 127c and 162c.)

[3] The second leaf inoculated.

[4] Slight discolored areas appeared on the inoculated parts.

[5] A good infection, conidia being produced.

[6] Two leaves inoculated.

[7] A good infection of one leaf, and the lower leaf sheaths of one plant.

[8] Three leaves inoculated.

[9] A fair infection of one leaf.

[10] The second leaf of one plant and the fourth leaf of the other inoculated.

[11] A good infection of one leaf.

[12] The second and third leaves inoculated.

[13] A small infected area appeared on one leaf.

TABLE XVII. — RESULTS WITH *Triticum compactum* Host [1]

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1908					1908		
105b	June 24	*Triticum vulgare*	4	2	1	June 30	+ + +	—
106c	" 24	" "	4	2	0	" 30	+ + +	....
107b	" 24	" "	4	2	2	" 30	+ + +	—
108b	July 7	" "	6	1	1	July 14	+ + +	—
109c	" 7	" "	6	4	2	" 14	+ + +	—
110a	" 7	" "	6	4	3	" 14	+ + +	—
118a	" 22	" "	5	2	2	" 29	+ + +	—
139a	Oct. 31	" "	7	5	3	Nov. 7	+ + +	—
144a	" 31	" "	7	10	4	" 7	+ + +	—

[1] *Triticum sativum compactum* Hackel. The variety *creticum* was used in all the tests.

sown on seedlings of this plant. Altogether twelve tests were made, fifty-eight plants being inoculated. Salmon, however, states that three plants out of twelve inoculated became infected. The species shows a marked resistance to the barley mildew, even though it may not be entirely immune.

When rye (*Secale cereale*) was inoculated with the barley or wheat mildew, no infection occurred. This was clearly shown through the large number of tests made. If, however, rye plants were inoculated with rye mildew, full and complete infection took place. Furthermore, the mildew on rye was capable, according to Marchal, of infecting *Secale anatolicum*. I have found that three plants of *S. montanum* out of twelve inoculated became infected. In these successful infections there was a very vigorous growth of mildew. In the three attempts made with *Secale dalmaticum* no infection occurred.

Conidia from wheat (*Triticum vulgare*) failed to infect any of the other cereals. Conidia from this same host, however, produced full and complete infection upon all of the eleven species of *Triticum* tested. Every plant of *Triticum compactum*, *T. durum* (six varieties), *T. Freycenetii*, *T. polonicum*, *T. Spelta*, *T. Thaoudar*, *T. Tumonia*, *T. turgidum*, and *T. vulgare* which were inoculated with conidia from wheat, became infected.

Fifty-seven leaves of *Triticum monococcum* were inoculated and forty-seven of these became infected. In most cases a good, vigorous growth of mildew was present.

TABLE XVIII. — RESULTS WITH *Triticum dicoccum* Schrank[1]

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1908					1908		
34a[2]	Jan. 2	*Hordeum vulgare*	8	4	4	Jan. 11	—	—
111b[2]	July 10	" "	7	3	2	July 18	—	—
99a[2]	Mar. 3	*Hordeum Zeocriton*	7	2	1	Mar. 10	—	—
39a[2]	Jan. 17	*Triticum dicoccum*	13	2	3	Jan. 24	+++	—
40b[2]	" 17	" "	13	3	4	" 24	+++	—
60c[2]	Feb. 1	*Triticum polonicum*	8	2	1	Feb. 10	+++	—
74c[2]	" 10	" "	9	3	3	" 17	+++	—
93c[2]	" 22	" "	9	2	2	" 29	++	—
56b[2]	" 1	*Triticum Spelta*	8	1	3	" 10	+++	—
69a[2]	" 10	" "	9	3	3	" 17	+++	—
70a[2]	" 10	" "	9	3	2	" 17	+++	—
94b[2]	Mar. 3	" "	7	3	1	Mar. 10	+++	—
95a[2]	" 3	" "	7	3	4	" 10	+++	—
30a[2]	Jan. 2	*Triticum vulgare*	8	4	3	Jan. 11	+++	—
31b[2]	" 2	" "	8	2	3	" 11	+++	—
43a[2]	" 17	" "	13	4	4	" 24	+++	—
50c[2]	" 24	" "	10	4	2	" 30	+++	—
55a[2]	" 24	" "	10	3	2	" 30	+++	—
62b[2]	Feb. 3	" "	10	2	0	Feb. 10	+++	....
89c[2]	" 22	" "	9	3	2	" 29	+++	—
91b[2]	" 22	" "	9	3	3	" 29	+++	—
96b[2]	Mar. 3	" "	7	3	1	Mar. 10	+++	—
97a[2]	" 3	" "	7	3	2	" 10	+++	—
149c[2]	Nov. 2	" "	9	4	2	Nov. 7	+++	—
150b[2]	" 2	" "	9	5	3	" 7	+++	—
184a[2]	" 27	" "	6	8	8	Dec. 5	+++	—
193c[2]	Dec. 14	" "	24	2[3]	2	" 20	+++	+[4]
156a[5]	Nov. 10	" "	7	4	4	Nov. 19	+++	—
157b[5]	" 10	" "	7	4	3	" 19	+++	—
166b[5]	" 20	" "	6	9	9	" 26	+++	—
169b[5]	" 20	" "	6	6	1	" 26	+++	—
182c[5]	" 27	" "	6	9	7	Dec. 5	+++	—
193b[5]	Dec. 14	" "	24	3[3]	2	" 20	+	—
155c[6]	Nov. 10	" "	7	5	4	Nov. 19	—	—
161b[6]	" 12	" "	9	5	4	" 21	—	—
165b[6]	" 20	" "	6	8	3	" 26	—	—
167c[6]	" 20	" "	6	7	4	" 26	—	—
182a[6]	" 27	" "	6	8	6	Dec. 5	—	—
183b[6]	" 27	" "	6	4	2	" 5	++	—
184c[6]	" 27	" "	6	7	7	" 5	—	
154b[7]	" 10	" "	7	5[8]	3	Nov. 19	+	-
155b[7]	" 10	" "	7	4	7	" 19	—	—
166c[7]	" 20	" "	6	4	7	" 26	—	—
169a[7]	" 20	" "	6	5	6	" 26	—	—
183c[7]	" 27	" "	6	8	4	Dec. 5	—	—
193a[7]	Dec. 14	" "	24	2[3]	2	" 20	—	—
64c[9]	Feb. 3	*Hordeum vulgare*	10	4	8	Feb. 10	—	—
71c[9]	" 10	*Triticum dicoccum*	9	3	2	" 17	+[10]	—
72a[9]	" 10	" "	9	3	2	" 17	—	—
83c[9]	" 21	*Triticum durum*	8	4	6	" 29	—	—
84c[9]	" 21	" "	8	3	3	" 29	—	—
56a[9]	" 1	*Triticum Spelta*	8	3	6	" 10	—	—

TABLE XVIII. — RESULTS WITH *Triticum dicoccum* Schrank.[1] — *Continued*

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1908					1908		
57b[9]	Feb. 1	*Triticum Spelta*	8	4	5	Feb. 10	—	—
69c[9]	" 10	" "	9	2	3	" 17	+[10]	—
95b[9]	Mar. 3	" "	7	3	3	Mar. 10	—	—
49b[9]	Jan. 24	*Triticum vulgare*	10	4	2	Jan. 30	—	—
50b[9]	" 24	" "	10	3	2	" 30	—	—
54a[9]	" 24	" "	10	3	3	" 30	—	—
89b[9]	Feb. 22	" "	9	4	4	Feb. 29	—	—
90b[9]	" 22	" "	9	3	3	" 29	—	—
96a[9]	Mar. 3	" "	7	3	3	Mar. 10	—	—
97b[9]	" 3	" "	7	3	3	" 10	—	—
103c[9]	May 16	" "	10	2	1	May 24	++[11]	—
104c[9]	" 30	" "	6	2	3	June 10	—	—
108c[9]	July 7	" "	4	3	2	July 14	—	—
143a[9]	Oct. 31	" "	7	5	9	Nov. 7	—	—
165a[9]	Nov. 20	" "	6	5	5	" 26	—	—
185c[9]	" 27	" "	13	2[12]	1	Dec. 5	—	—

[1] *Triticum sativum dicoccum* Hackel.

[2] Black Winter Emmer.

[3] Two leaves of each plant inoculated.

[4] A slight infection of one control plant.

[5] Red Emmer.

[6] Common Emmer.

[7] Russian Emmer.

[8] One seedling had a different appearance from the others and was well infected with the mildew. Evidently the seedling was not a plant of Russian Emmer.

[9] White Emmer.

[10] Slight discolored areas were present on one of the inoculated leaves.

[11] A good infection of one leaf of one plant, the mildew appearing on the leaf-sheath and the lower portion of the blade.

[12] The second leaf and sheath of each plant inoculated.

Five varieties of Emmer (*Triticum dicoccum*) were tested with the wheat mildew. As seen from the table, two varieties (Black Emmer and Red Emmer) were entirely susceptible to the mildew. Every plant inoculated became infected, and the growth of the fungus was as vigorous as ever appeared upon wheat. The other three varieties (White Emmer, Common Emmer, and Russian Emmer) proved quite resistant to the mildew. Out of forty-four leaves of Common Emmer inoculated, four showed infection. Out of sixty-seven leaves of White Emmer inoculated, three became infected; and none of the twenty-seven plants of Russian Emmer

TABLE XIX. — RESULTS WITH *Triticum durum* Desf.[1]

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1908					1908		
111a[2]	July 10	*Hordeum vulgare*	7	3	5	July 18	—	—
58b[2]	Feb. 1	*Triticum durum*	8	1	0	Feb. 10	+++	....
84a[2]	" 21	" "	8	3	2	" 29	+++	—
73b[2]	" 10	*Triticum polonicum*	9	2	1	" 17	+++	—
74a[2]	" 10	" "	9	2	1	" 17	+++	—
93a[2]	" 22	" "	9	1	1	" 29	+++	—
70b[2]	" 10	*Triticum Spelta*	9	3	1	" 17	+++	—
51b[2]	Jan. 24	*Triticum vulgare*	10	2	2	Jan. 30	+++	—
52a[2]	" 24	" "	10	1	1	" 30	+++	—
53a[2]	" 24	" "	10	3	1	" 30	+++	—
63a[2]	Feb. 3	" "	10	1	1	Feb. 10	+++	—
91a[2]	" 22	" "	9	2	3	" 29	+++	—
139b[3]	Oct. 31	" "	7	5	4	Nov. 7	+++	—
140a[3]	" 31	" "	7	4	5	" 7	+++	—
140b[4]	" 31	" "	7	3	2	" 7	+++	—
142b[4]	" 31	" "	7	3	4	" 7	+++	—
140c[5]	" 31	" "	7	4	2	" 7	+++	—
144b[5]	" 31	" "	7	5	1	" 7	+++	—
141a[6]	" 31	" "	7	2	3	" 7	+++	—
149b[6]	Nov. 2	" "	9	1	0	" 7	+++	....
141c[7]	Oct. 31	" "	7	2	2	" 7	+++	—
149a[7]	Nov. 2	" "	9	2	1	" 7	+++	—
144c[8]	Oct. 31	" "	7	4	3	" 7	+++	—
150c[8]	Nov. 2	" "	9	3	3	" 7	+++	—
156c[9]	" 10	" "	7	3	4	" 19	+++	—
161c[9]	" 12	" "	9	3	2	" 21	+++	—

[1] *Triticum sativum durum* Hackel.
[2] Var. Kubanka.
[3] Var. Black Don.
[4] Var. Medeah.
[5] Var. Chilean.
[6] Var. *affine*.
[7] Var. Wild Goose.
[8] Var. Velvet Don.
[9] Var. Soretina Spring Wheat

TABLE XX. — RESULTS WITH *Triticum Freycenetii* Hort.

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1908					1908		
122b	July 28	*Triticum vulgare*	4	6	4	Aug. 5	++	—
123a	" 28	" "	4	6	2	" 5	++	—
128a	Oct. 19	" "	6	3	3	Oct. 26	+++	—
129c	" 19	" "	6	5	2	" 26	+++	—
166a	Nov. 20	" "	6	5	1	Nov. 26	+++	—
167b	" 20	" "	6	3	2	" 26	+++	—
182b	" 27	" "	6	2	3	Dec. 5	+-	—
184b	" 27	" "	6	4	4	" 5	+++	—

TABLE XXI. — RESULTS WITH *Triticum monococcum* L.

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1908					1908		
114c[1]	July 14	*Triticum compactum*	4	2	1	July 22	++	—
102b[2]	May 16	*Triticum vulgare*	10	1	0	May 24	—	....
104b[2]	" 30	" "	24	1[3]	0	June 10	—	....
105c[2]	June 24	" "	4	1	0	" 30	+	....
106b[2]	" 24	" "	4	2	1	" 30	++	—
107c[2]	" 24	" "	4	1	0	" 30	+++	....
108a[2]	July 7	" "	7	1	1	July 14	—	—
109a[2]	" 7	" "	7	2	1	" 14	—	—
110b[2]	" 7	" "	7	2	1	" 14	+++	—
117c[1]	" 22	" "	5	3	2	" 29	+++	—
118b[1]	" 22	" "	5	3	1	" 29	+++	—
123c[4]	" 28	" "	4	2	1	Aug. 5	+++	—
129b[4]	Oct. 19	" "	6	4	1	Oct. 26	++	—
143c[4]	" 31	" "	7	5	4	Nov. 7	+++	—
150a[4]	Nov. 2	" "	9	2	1	" 7	+++	—
156b[4]	" 10	" "	7	3	4	" 19	—	—
162b[4]	" 12	" "	9	3	2	" 21	++	—
125c[5]	July 28	" "	4	3	3	Aug. 5	+++	—
128b[5]	Oct. 19	" "	6	3	4	Oct. 26	+[6]	—
142c[5]	" 31	" "	7	3	2	Nov. 7	++	—
145b[5]	" 31	" "	7	3	3	" 7	+++	—
157c[5]	Nov. 10	" "	7	3	1	" 19	+++	—
160b[5]	" 12	" "	9	4	1	" 20	++	—

[1] Seed obtained from Vilmorin-Andrieux Co., of Paris.

[2] Seed obtained from Dr. Wm. Trelease.

[3] Two leaves inoculated.

[4] Variety *Hornemanni*.

[5] Variety *vulgare*. Varieties *Hornemanni* and *vulgare* were obtained from the Botanical Garden at Tábor, Bohemia.

[6] A very good infection of one leaf.

became infected. There is, therefore, a marked difference in susceptibility of these five varieties. It is to be noted here, that Marchal obtained negative results when he sowed conidia from wheat on *Triticum dicoccum*. His results may be due to the fact that he was working with an immune variety. It is apparent from my results that some varieties are quite susceptible, while others are almost or entirely immune.

My results show two other interesting differences from those of Marchal. In my work, six different varieties of *Triticum durum* were tested. In every case full infection followed. Marchal, on the other hand, states that this species is immune to the wheat

TABLE XXII.—RESULTS WITH *Triticum polonicum* L.

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1908					1908		
71a	Feb. 10	*Triticum dicoccum*	9	2	1	Feb. 17	+ + +	—
59c	" 1	*Triticum durum*	8	3	2	" 10	+ + +	—
73c	" 10	*Triticum polonicum*	9	1	1	" 17	+ + +	—
57a	" 1	*Triticum Spelta*	8	3	1	" 10	+ + +	—
51a	Jan. 24	*Triticum vulgare*	10	3	2	Jan. 30	+ + +	—
52c	" 24	" "	10	3	2	" 30	+ + +	—
53b	" 24	" "	10	3	1	" 30	+ + +	—
62c	Feb. 3	" "	10	2	0	Feb. 10	+ + +	..
75b	" 10	" "	9	1	0	" 17	+ + +	..
92a	" 22	" "	9	3	3	" 29	+ + +	—
168c	Nov. 20	" "	6	3	4	Nov. 26	+ + +	—
169c	" 20	" "	6	3	2	" 26	+ + +	—

TABLE XXIII. — RESULTS WITH *Triticum Spelta* L.[1]

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1908					1908		
72c	Feb. 10	*Triticum dicoccum*	9	2	2	Feb. 17	+ + +	—
59a	" 1	*Triticum durum*	8	4	6	" 10	+ + +	—
83b	" 21	" "	8	3	3	" 29	+ + +	—
84b	" 21	" "	8	4	4	" 29	+ + +	—
61c	" 1	*Triticum polonicum*	8	2	4	" 10	+ + +	—
74b	" 10	" "	9	3	1	" 17	+ + +	—
56c	" 1	*Triticum Spelta*	8	4	7	" 10	+ + +	—
69b	" 10	" "	9	3	3	" 17	+ + +	—
49c	Jan. 24	*Triticum vulgare*	10	3	2	Jan. 30	+ + +	—
54c	" 24	" "	10	3	3	" 30	+ + +	—
55b	" 24	" "	10	3	3	" 30	+ + +	—
89a	Feb. 22	" "	9	6	3	Feb. 29	+ + +	—
102c	May 16	" "	10	4[2]	3	May 24	+ + +	—
103b	" 16	" "	10	2[2]	2	" 24	+ + +	—
110c	July 7	" "	4	3	2	July 14	+ + +	—
134c	Oct. 21	" "	8	6	3	Oct. 30	+ + +	—
139c	" 31	" "	7	3	5	Nov. 7	+ + +	—
142a	" 31	" "	7	5	5	" 7	+ + +	—

[1] *Triticum sativum Spelta* Hackel.

[2] Two leaves of each plant inoculated.

mildew. The other case is with reference to *Triticum monococcum*, which Marchal claims gave negative results. As already stated, forty-seven out of fifty-seven leaves inoculated became infected in the tests which I made.

It is evident from this review that the mildew on each of the

TABLE XXIV.—RESULTS WITH *Triticum Thaoudar* Boiss.

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1908					1908		
125a	July 28	*Triticum vulgare*	4	4	4	Aug 5	+++	—
127b	Oct. 19	" "	6	4	2	Oct. 26	+++	—
145a	" 31	" "	7	4	2	Nov. 7	+++	—
148a	Nov. 2	" "	9	6	2	" 7	+++	—
154a	" 10	" "	7	2	1	" 19	+++	—
160a	" 12	" "	9	4	2	" 20	+++	—

TABLE XXV.—RESULTS WITH *Triticum Tumonia* Schrad.

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1908					1908		
124b	July 28	*Triticum vulgare*	4	3	2	Aug. 5	+++	—
134a	Oct. 21	" "	8	1	0	Oct. 30	+++	....
155a	Nov. 10	" "	7	2	0	Nov. 19	+++	....
161a	" 12	" "	9	3	1	" 21	+++	—

TABLE XXVI. — RESULTS WITH *Triticum turgidum* L.[1]

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1908					1908		
113a	July 14	*Triticum vulgare*	4	4	2	July 21	+++	—
114b	" 14	" "	4	2	1	" 21	+++	—
117b	" 22	" "	5	1	0	" 29	+++	...
124c	" 28	" "	4	2	2	Aug. 5	+++	—
126b	" 28	" "	4	3	2	" 5	+++	—
134b	Oct. 21	" "	8	2[2]	1	Oct. 30	+++	—
165c	Nov. 20	" "	6	3	2	Nov. 26	+++	—
167a	" 20	" "	6	3	2	" 26	+++	—
168a	" 20	" "	6	3	3	" 26	+++	—

[1] *Triticum sativum turgidum* Hackel.

[2] Two leaves of each plant inoculated.

four cereals is restricted to the species of each genus. The mildew on oats occurs on species of *Avena* only; the barley mildew on species of *Hordeum* only; the rye mildew on species of *Secale* only; and the wheat mildew on species of *Triticum* only.

TABLE XXVII. — RESULTS WITH *Triticum vulgare* Vill.[1]

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1907					1907		
10b	Dec. 24	*Hordeum vulgare*	10	3	3	Dec. 30	—	—
10c	" 24	" "	10	3	3	" 30	—	—
11a	" 24	" "	10	5	4	" 30	—	—
11c	" 24	" "	10	2	4	" 30	—	—
12c	" 24	" "	10	2	2	" 30	—	—
14a	" 25	" "	11	4	5	" 30	—	—
15b	" 25	" "	11	3	4	" 30	—	—
						1908		
20a	" 31	" "	10	4	4	Jan. 7	—	—
22b	" 31	" "	10	2	2	" 7	—	—
	1908							
36a	Jan. 2	" "	8	3	3	" 11	—	+[2]
37a	" 2	" "	8	3	3	" 11	—	—
47c	" 18	" "	14	2	3	" 24	—	—
112b	July 10	" "	7	6	6	July 18	—	—
98a	Mar. 3	*Hordeum Zeocriton*	7	3	2	Mar. 10	—	—
100a	" 3	" "	7	2	1	" 10	—	—
101b	" 3	" "	7	3	3	" 10	—	—
114a	July 14	*Triticum compactum*	4	3	3	July 22	+++	—
39b	Jan. 17	*Triticum dicoccum*	13	3	4	Jan. 24	+++	—
40a	" 17	" "	13	3	3	" 24	+++	—
71b	Feb. 10	" "	9	3	3	Feb. 17	+++	—
72b	" 10	" "	9	2	2	" 17	+++	—
58c	" 1	*Triticum durum*	8	2	3	" 10	+++	—
60b	" 1	*Triticum polonicum*	8	2	2	" 10	+++	—
61a	" 1	" "	8	2	1	" 10	+++	—
73a	" 10	" "	9	3	1	" 17	+++	—
57c	" 1	*Triticum Spelta*	8	1	1	" 10	+++	—
70c	" 10	" "	9	2	2	" 17	+++	—
	1907					1907		
16a	Dec. 25	*Triticum vulgare*	11	3	3	Dec. 30	+++	—
17c	" 25	" "	11	2	6	" 30	+++	—
18b	" 25	" "	11	3	5	" 30	+++	—
19b	" 25	" "	9	3	4	" 30	+++	—
						1908		
26a	" 31	" "	10	2	2	Jan. 7	+++	—
27c	" 31	" "	10	2	3	" 7	+++	—
28c	" 31	" "	10	1	1	" 7	+++	—
29b	" 31	" "	10	3	3	" 7	+++	—
	1908							
30b	Jan. 2	" "	8	3	2	" 11	+++	—
31c	" 2	" "	8	2	2	" 11	+++	—
32c	" 2	" "	8	3	2	" 11	+++	—
33c	" 2	" "	8	3	3	" 11	+++	—
41a	" 17	" "	13	2	2	" 24	+++	—
42c	" 17	" "	13	3	3	" 24	+++	—
43b	" 17	" "	13	3	3	" 24	+++	—
49a	" 24	" "	10	3	2	" 30	+++	—
50a	" 24	" "	10	3	1	" 30	+++	—
51c	" 24	" "	10	3	2	" 30	+++	—
52b	" 24	" "	10	2	3	" 30	+++	—
53c	" 24	" "	10	3	2	" 30	+++	—

TABLE XXVII. — RESULTS WITH *Triticum vulgare* Vill.[1]—*Continued.*

Number of experiment	Date	Source of conidia	Age of plants (days)	No. of plants inoculated	No. of controls	Results		
						Date	Inoc. plants	Controls
	1908					1908		
54b	Jan. 24	*Triticum vulgare*	10	3	2	Jan. 30	+++	—
55c	" 24	" "	10	3	1	" 30	+++	—
63b	Feb. 3	" "	10	2	1	Feb. 10	+++	—
75c	" 10	" "	9	2	3	" 17	+++	—
76c	" 10	" "	9	4	2	" 17	+++	—
90c	" 22	" "	11	3	3	" 29	+++	—
92b	" 22	" "	11	4	4	" 29	+++	—
97c	Mar. 3	" "	7	3	3	Mar. 10	+++	—
102a	May 16	" "	10	2[3]	2	May 24	++	—
103a	" 16	" "	10	2[3]	1	" 24	+++	—
104a	" 30	" "	6	2	2	June 10	+++	—
105a	June 24	" "	4	3	3	" 30	+++	—
106a	" 24	" "	4	4	3	" 30	+++	—
107a	" 24	" "	4	2	2	" 30	+++	—
109a	July 7	" "	4	3	2	July 14	+++	—
113b	" 14	" "	4	3	4	" 22	+++	—
117b	" 22	" "	5	1	0	" 29	+++	....
118c	" 22	" "	5	3	2	" 29	+++	—
122a	" 28	" "	4	3	2	Aug. 5	+++	—
123b	" 28	" "	4	3	2	" 5	+++	—
124a	" 28	" "	4	3	5	" 5	+++	—
125b	" 28	" "	4	2	3	" 5	+++	—
126c	" 28	" "	4	2	3	" 5	+++	—
127a	Oct. 19	" "	6	2	2	Oct. 26	+++	—
128c	" 19	" "	6	2	2	" 26	+++	—
129a	" 19	" "	6	3	1	" 26	+++	—
141b	" 31	" "	7	3	3	Nov. 7	+++	—
143b	" 31	" "	7	4	3	" 7	+++	—
148b	Nov. 2	" "	9	3	6	" 7	+++	—
154c	" 10	" "	7	2	1	" 19	+++	—
157a	" 10	" "	7	2	2	" 19	+++	—
160c	" 12	" "	9	6	3	" 20	+++	—
162a	" 12	" "	9	2	2	" 21	+++	—
183a	" 27	" "	6	5	3	Dec. 5	+++	—
185a	" 27	" "	6	4	1	" 5	+++	—

[1] *Triticum sativum vulgare* Hackel.

[2] Two small infected areas appeared on one leaf of a control.

[3] Two leaves of each plant inoculated.

So far as tested, all species of *Avena* are susceptible to the oat mildew. All species of *Triticum* are likewise susceptible to the wheat mildew. We find, however, that certain varieties of *Triticum dicoccum* are practically immune to the wheat mildew. Other varieties of this same species are entirely susceptible. Some species of *Hordeum* are immune to the barley mildew, and the same seems to be true of certain species of *Secale* with reference to the rye mildew.

TABLE XXVIII. — GENERAL SUMMARY OF RESULTS WITH THE MILDEWS OF THE CEREALS

Host plant	Conidia from *Avena sativa*		Conidia from *Hordeum vulgare*			Conidia from *Secale cereale*		Conidia from *Triticum vulgare*		
	Marchal	Salmon	Marchal	Salmon	Reed	Marchal	Reed	Marchal	Salmon	Reed
Agropyron repens	—	.....	—	.....	.....	—	.....	—	3, 8, 0	.....
Alopecurus pratensis	.....	1, 4, 0	.....	.....	.....	.....	.....	.....	.....	.....
Arrhenatherum elatius	+	1, 3, 0	.....	.....	.....	.....	.....	.....	.....	.....
Avena brevis	.....	2, 5, 5	.....	.....	.....	.....	.....	.....	.....	.....
" *fatua*	+	.....	.....	.....	.....	.....	.....	.....	.....	.....
" *nuda*	.....	1, 3, 3	.....	.....	.....	.....	.....	.....	.....	.....
" *orientalis*	+	4, 4, 4	.....	.....	.....	.....	.....	.....	.....	.....
" *sativa*	+	8, 23, 23	—	1, 3, 0	22[1], 62, 0	—	16, 49, 0	—	3, 11, 0	14[2], 48, 0
" *sterilis*	.....	2, 3, 3	.....	.....	.....	.....	.....	.....	.....	.....
" *strigosa*	.....	2, 4, 4	.....	.....	.....	.....	.....	.....	.....	.....
Bromus mollis	.....	.....	.....	.....	.....	.....	5, 12, 0	.....	.....	.....
Dactylis glomerata	.....	2, 9, 0	.....	.....	.....	.....	8, 16, 0	.....	.....	.....
Festuca elatior	.....	.....	.....	.....	.....	.....	8, 21, 0	.....	.....	.....
" " *arundinacea*	.....	1, 4, 0	.....	.....	.....	.....	.....	.....	.....	.....
" " *pratensis*	.....	1, 4, 0	.....	.....	.....	.....	.....	.....	.....	.....
" *heterophylla*	.....	1, 4, 0	.....	.....	.....	.....	8, 42, 0	.....	.....	.....
Glyceria fluitans	.....	.....	.....	.....	.....	.....	5, 19, 0	.....	.....	.....
Hordeum bulbosum	.....	.....	—	5, 14, 1	12, 24, 1	.....	.....	.....	.....	.....
" *decipiens*	.....	.....	.....	5, 15, 15	.....	.....	.....	.....	.....	.....
" *distichon*	.....	.....	.....	5, 15, 15	25[3], 73, 73	.....	.....	.....	.....	2, 5, 0
" *hexastichon*	.....	.....	+	4, 12, 12	.....	.....	.....	.....	.....	.....
" *intermedium*	.....	.....	.....	1, 3, 3	.....	.....	.....	.....	.....	.....
" *jubatum*	.....	.....	+	8, 25, 0	6, 17, 0	.....	8, 32, 0	.....	.....	.....
" *maritimum*	.....	.....	—	3, 12, 3	12, 58, 0	.....	.....	.....	.....	.....
" *murinum*	.....	.....	+	5, 16, 0	.....	.....	.....	.....	.....	.....
" *nodosum*[4]	.....	.....	.....	.....	13, 64, 51	.....	.....	.....	.....	.....
" *nudum*	.....	.....	+	.....	19[5], 45, 45	.....	.....	.....	.....	2[6], 3, 0
" *secalinum*[4]	.....	.....	—	3, 9, 0	.....	.....	.....	.....	.....	.....
" *silvaticum*	.....	.....	.....	4, 12, 0	.....	.....	.....	.....	+[7]	.....
" *Steudelii* × *trifurcatum*	.....	.....	.....	.....	9, 26, 26	.....	.....	.....	.....	.....
" *tetrastichon*	.....	.....	.....	.....	7, 26, 26	.....	.....	.....	.....	.....
" *trifurcatum*	.....	.....	+	.....	5, 13, 13	.....	.....	.....	.....	.....
" *vulgare*	—	1, 6, 0	+	24, 70, 70	49[8], 150, 150	—	15, 45, 0	—	3, 12, 0	18[9], 47, 0

TABLE XXVIII. — GENERAL SUMMARY OF RESULTS WITH THE MILDEWS OF THE CEREALS.—*Continued*

Host-plant	Conidia from *Avena sativa*		Conidia from *Hordeum vulgare*			Conidia from *Secale cereale*		Conidia from *Triticum vulgare*		
	Marchal	Salmon	Marchal	Salmon	Reed	Marchal	Reed	Marchal	Salmon	Reed
Hordeum Zeocriton	.....	.....	.....	3, 9, 9	23^{10}, 63, 63	.....	.....	.....	.....	1, 3, 0
Lolium italicum	.....	1, 3, 0	.....	.....	.....	.....	.....	.....	.....	.....
" *perenne*	.....	.....	.....	.....	.....	.....	9, 39, 0	.....	.....	.....
Phleum pratense	.....	1, 4, 0	.....	.....	.....	.....	9, 52, 0	.....	.....	.....
Poa annua	.....	2, 9, 0	.....	.....	.....	.....	.....	.....	.....	.....
" *compressa*	.....	.....	.....	.....	.....	.....	5, 16, 0	.....	.....	.....
" *nemoralis*	.....	.....	.....	.....	.....	.....	9, 40, 0	.....	.....	.....
" *pratensis*	.....	.....	.....	.....	.....	.....	12, 75, 0	.....	.....	.....
" *trivialis*	.....	.....	.....	.....	.....	.....	6, 35, 0	.....	.....	.....
Secale anatolicum	.....	.....	.....	.....	.....	+	.....	.....	.....	.....
" *cereale*	—	2, 6, 0	—	1, 3, 0	11^{11}, 24, 0	+	58, 138, 131	—	2, 8, 0	10^{12}, 25, 0
" *dalmaticum*	.....	.....	.....	.....	.....	.....	3, 3, 0	.....	.....	.....
" *montanum*	.....	.....	.....	.....	.....	.....	8, 12, 3	.....	.....	.....
" *cereale* × *Triticum vulgare*	.....	.....	.....	.....	.....	.....	13, 18, 9	.....	.....	10, 16, 1
Trisetum pratense	.....	1, 4, 0	.....	.....	.....	.....	.....	.....	.....	.....
Triticum compactum	.....	.....	.....	.....	.....	.....	.....	.....	.....	9, 32, 32
" *dicoccum*[13]	.....	.....	.....	.....	3^{14}, 9, 0	.....	.....	.....	.....	24^{15}, 75, 75
" *dicoccum*[16]	.....	.....	.....	.....	.....	.....	.....	.....	.....	6, 35, 35
" *dicoccum*[17]	.....	.....	.....	.....	.....	.....	.....	.....	.....	7, 44, 4
" *dicoccum*[18]	.....	.....	.....	.....	.....	.....	.....	.....	.....	6, 27, 0^{19}
" *dicoccum*[20]	.....	.....	.....	.....	1, 4, 0	.....	.....	.....	.....	21^{21}, 67, 3^{22}
" *durum*	.....	.....	.....	.....	1, 3, 0	.....	.....	—	.....	25^{23}, 65, 65
" *Freycenetii*	.....	.....	.....	.....	.....	.....	.....	.....	.....	8, 34, 34
" *monococcum*	.....	.....	.....	.....	.....	.....	.....	—	.....	23^{24}, 57, 47
" *polonicum*	.....	.....	.....	.....	.....	.....	.....	+	.....	12^{25}, 30, 30
" *Spelta*	.....	.....	.....	.....	.....	.....	.....	+	2, 6, 6	18^{26}, 63, 63
" *Thaoudar*	.....	.....	.....	.....	.....	.....	.....	.....	.....	6, 24, 24
" *Tumonia*	.....	.....	.....	.....	.....	.....	.....	.....	.....	4, 9, 9
" *turgidum*	.....	.....	.....	.....	.....	.....	.....	+	.....	9, 23, 23
" *vulgare*	—	2, 12, 0	—	1, 3, 0	16^{27}, 50, 0	—	24, 66, 0	+	5, 19, 19	66^{28}, 178, 178

[1] Includes five tests, sixteen plants inoculated with conidia from *Hordeum distichon*, and four tests, nine plants inoculated with conidia from *H. Zeocriton*.

[2] Includes one test, three plants inoculated with conidia from *Triticum durum*; one test, five plants inoculated with conidia from *T. polonicum*; and two tests, seven plants inoculated with conidia from *T. Spelta*.

[3] Includes six tests, twenty-three plants inoculated with conidia from *Hordeum distichon*; one test, five plants inoculated with conidia from *H. nudum*; and one test, three plants inoculated with conidia from *H. Zeocriton*.

[4] In the Index Kewensis, *Hordeum nodosum* L. is given as a synonym for *Hordeum secalinum* Schreb. I am uncertain, however, whether Salmon's work was with the same species as the one I tested.

[5] Includes six tests, fourteen plants inoculated with conidia from *Hordeum distichon*; and two tests, six plants inoculated with conidia from *H. nudum*.

[6] Includes one test, one plant inoculated with conidia from *Triticum polonicum*.

[7] Young leaves, when inoculated, became infected.

[8] Includes three tests, ten plants inoculated with conidia from *Hordeum distichon*; one test, one plant inoculated with conidia from *H. nodosum*; one test, four plants inoculated with conidia from *H. nudum*; and five tests, thirteen plants inoculated with conidia from *H. Zeocriton*.

[9] Includes two tests, five plants inoculated with conidia from *Triticum dicoccum*; one test, two plants inoculated with conidia from *T. durum*; one test, two plants inoculated with conidia from *T. polonicum*; and one test, one plant inoculated with conidia from *T. Spelta*.

[10] Includes four tests, sixteen plants inoculated with conidia from *Hordeum distichon*; two tests, seven plants inoculated with conidia from *H. nudum*; and one test, three plants inoculated with conidia from *H. Zeocriton*.

[11] Includes three tests, seven plants inoculated with conidia from *Hordeum distichon*.

[12] Includes one test, three plants inoculated with conidia from *Triticum durum*.

[13] Black Winter Emmer. It may be noted here that Marchal obtained negative results with the wheat mildew on *Triticum dicoccum*. He does not state what variety was used.

[14] Includes one test, two plants inoculated with conidia from *Hordeum Zeocriton*.

[15] Includes two tests, five plants inoculated with conidia from *Triticum dicoccum*; three tests, seven plants inoculated with conidia from *T. polonicum*; and five tests, thirteen plants inoculated with conidia from *T. Spelta*.

[16] Red Emmer.

[17] Common Emmer.

[18] Russian Emmer.

[19] As noted in Table XVIII, exp. 154*b*, one of the plants was plainly not a seedling of the Russian Emmer. This seedling, as already noted, became well infected.

[20] White Emmer.

[21] Includes two tests, six plants inoculated with conidia from *Triticum dicoccum*; two tests, seven plants inoculated with conidia from *T. durum*; and four tests, twelve plants inoculated with conidia from *T. Spelta*.

[22] Discolored areas were observed on inoculated leaves of two plants.

[23] Six different varieties were used. The figures include two tests, four plants inoculated with conidia from *Triticum durum*; three tests, five plants inoculated with conidia from *T. polonicum*; and one test, three plants inoculated with conidia from *T. Spelta*.

[24] Three varieties were used. The results include one test, two plants inoculated with conidia from *Triticum compactum*.

[25] Includes one test, two plants inoculated with conidia from *Triticum dicoccum*; one test, three plants inoculated with conidia from *T. durum*; one test, one plant inoculated with conidia from *T. polonicum*; and one test, three plants inoculated with conidia from *T. Spelta*.

[26] Includes one test, two plants inoculated with conidia from *Triticum dicoccum*; three tests, eleven plants inoculated with conidia from *T. durum*; two tests, five plants inoculated with conidia from *T. polonicum*; and two tests, seven plants inoculated with conidia from *T. Spelta*.

[27] Includes three tests, eight plants inoculated with conidia from *Hordeum Zeocriton*.

[28] Includes one test, three plants inoculated with conidia from *Triticum compactum*; four tests, eleven plants inoculated with conidia from *T. dicoccum*; one test, two plants inoculated with conidia from *T. durum*; three tests, seven plants inoculated with conidia from *T. polonicum*; and two tests, three plants inoculated with conidia from *T. Spelta*.

To these general statements there are two possible exceptions. Marchal states that the oat mildew will infect *Arrhenatherum elatius*. Salmon, however, obtained a negative result with the oat mildew on this grass. The evidence is not conclusive either way. The other exception is that, according to Salmon, conidia from wheat can infect *Hordeum silvaticum*. This species, however, is given in the Index Kewensis as *Elymus europaeus*. Furthermore, only young plants of this grass could be infected with the wheat mildew.

It would seem then that under normal conditions there are well-defined forms of *Erysiphe Graminis* occurring respectively on the species of each of the four cereals.

Especially interesting are the results with the hybrid between rye (*Secale cereale*) and wheat (*Triticum vulgare*). Professor Bubák, from whom I obtained the seed, informs me that the seed came originally from hybrids obtained by Rimpau in Germany.

So far as I can determine, a hybrid between rye and wheat has been obtained by three different workers. Wilson,[30] in 1875, placed rye pollen on the stigma of the wheat flower and thus secured a number of seeds. These seeds gave rise to plants the appearance of whose culm and head was intermediate between rye and wheat. The awns were midway in length between the short, blunt awns of the wheat, and the long, needle-like awns of the rye. The thickness of the culm and the slight villosity below the head were also rye characters. The hybrids were entirely

sterile. The anthers did not open; in fact, the pollen was imperfectly developed.

Carman * [10, 11, 12] has also obtained a hybrid between wheat and rye. In 1882 he placed pollen from rye on the stigma of a white club-wheat. From the seed obtained he was able to grow plants for several generations. In the first year there were eight plants, which yielded good grains. The next year the seed from these eight plants was sown and grew to strong, healthy plants, producing, however, a medley of wheat plants. Some had naked heads, others had long awns of various types, all, however, closely related to wheat. The ninth plant obtained in the first year resembled rye and produced apparently worthless grains. However, when these grains were planted, they gave rise to plants which had a strong resemblance to the parent rye. The plants were much taller than the original wheat plant. In the character of the head there was a close resemblance to wheat.

In 1888 Rimpau [23] attempted to cross wheat and rye. He took the pollen from the rye and placed it on the stigma of the wheat flower. He obtained one seed, which gave rise to a plant that had long and narrow awns; the haulms were 30 cm. longer than those of the wheat plants, differing especially in the length and narrowness of the ears from the mother parent. The grains secured from these plants were sown in 1890. One plant produced brown, short, sterile heads similar in form to the square-head wheat; two plants had white, fertile heads, similar to the square-head wheat; the other resembled in character the hybrids of the previous year, having very long, narrow, brown, wheat-like heads, which, however, had the more open flower characteristic of the rye.

As already stated, the seed which I used in my experiments came from this original cross by Rimpau. As seen from TABLE XVI, thirteen tests were made, eighteen plants being inoculated with conidia from the rye. Of these plants, nine showed evidences of infection. Six plants had a fairly good growth of mildew, conidia being produced. On the other three, however, only well-marked discolored areas appeared. In no case did I obtain the vigorous growth of mildew characteristic of this fungus on the rye plant.

* A good account of Carman's work is given by Barnard.[2]

Sixteen plants of the hybrid were inoculated with conidia from wheat in ten different tests. Of these plants, only one showed any evidence of infection. In experiment 168b, a small patch of mildew with conidia appeared.

In experiments 127c and 127d, different leaves of the same plant were inoculated, one with the rye mildew, the other with the wheat mildew. No infection occurred on either leaf. The same method was followed in experiments 162c and 162d. The leaf inoculated with conidia from rye showed a good growth of mildew, but the leaf inoculated with conidia from wheat gave no evidence whatever of infection.

It is apparent from my previous work that the wheat is entirely immune to the rye mildew. Twenty-four tests were made, in which sixty-six plants were inoculated with rye mildew, not one showing any evidence of infection. In contrast, every one of the one hundred and seventy-eight plants inoculated with wheat mildew, in sixty-six tests, became fully infected. The same thing holds true in the case of rye. Twenty-five rye plants, in ten tests, were inoculated with conidia from the wheat, but not one plant showed any evidence of infection. On the other hand, in a total of one hundred and thirty-eight plants inoculated with rye mildew, in fifty-eight tests, one hundred and thirty-one plants became infected.

The experiments with the rye-wheat hybrid clearly indicate that this hybrid is resistant to both the rye and the wheat mildew. It has, however, proved much more resistant to wheat mildew than to the rye, for only one infection occurred with this mildew. It would be interesting to know the entire history of the hybrid seed experimented with. I do not know to what generation the plants I worked with belonged, nor do I know whether they more closely resemble rye plants or wheat plants. I am growing the plants to maturity in order to determine the latter point.

In this connection it is interesting to mention an experiment by Eriksson[13] on some of Rimpau's rye-wheat hybrids. Eriksson found a form of *Puccinia dispersa* Eriks. & Henn. growing abundantly upon rye-wheat hybrids obtained from Rimpau. He states that the hybrid plants seemed to be more like the wheat than the rye. It is well known that there are two distinct forms of *Puccinia*

dispersa, the form *Secalis* on rye, and the form *Tritici* on wheat. Eriksson sowed uredospores from the infected hybrid upon three rye plants and also upon three wheat plants of the same age. Eleven days later a rich growth of the rust appeared upon the inoculated areas of the wheat plants. No infection occurred on the rye, although the plants were kept several days longer. It is apparent, then, that this hybrid had a well-marked resistance to the form *Secalis* of *Puccinia dispersa*, and was entirely susceptible to the form *Tritici*.

Some interesting questions are raised by the results obtained with the White Emmer, Russian Emmer, and Common Emmer, and also with the rye-wheat hybrid. These three Emmers are mildew-resistant varieties of *Triticum dicoccum*, two other varieties of this species (Black Winter Emmer and Red Emmer) proving quite susceptible to wheat mildew. The rye-wheat hybrid is the offspring of two parents, both of which are extremely susceptible to a particular mildew and also perfectly resistant to the form specialized on the other plant. The offspring inherits the resistance of both plants, and consequently cannot be fully infected by the fungus specialized on either the rye or the wheat. As has already been stated, the resistance of the hybrid to the wheat mildew is much more marked than is its resistance to the rye mildew.

Considerable interest has recently been manifested in breeding plants resistant to fungus-diseases. In general, two methods have been followed.* The seed of certain individual plants, which had proved able to withstand the attacks of the particular disease, is collected and used as a starting point for securing a disease-resistant variety. The other method has been to cross varieties that have been found to be resistant, with susceptible varieties, in order to combine in one type the resistant characters of the one with the productivity, adaptability for market, etc., of the other.

The first method has been followed by Blinn[5] in developing cantaloups resistant to a blight caused by *Macrosporium cucumerinum* Ellis & Everhart; by Bolley[6] in securing flax resistant to flax wilt (*Fusarium Lini* Bolley); by Bain and Essary[1] in

* For a more complete account of these methods, see a paper by the writer in the Second Annual Report of the State Board of Horticulture of Missouri, 284–286. 1909.

securing red clover resistant to *Colletotrichum Trifolii* Bain; by Jones [17] and others in securing potatoes resistant to late blight (*Phytophthora infestans* de Bary); and by Orton [19] in securing cowpeas resistant to the wilt fungus [*Neocosmospora vasinfecta* (Atk.) E. F. Smith].

A great deal has been done toward securing rust-resistant varieties of wheat and other cereals. For this purpose Carleton [8] has introduced into this country a number of foreign wheats, especially Russian varieties. The common bread wheats, varieties of *Triticum vulgare*, in general are quite susceptible to attacks of rust. On the other hand, many durum wheats, varieties of *Triticum durum*, are relatively immune, the variety Iumillo being almost perfectly resistant. During the season of 1904,[9] the loss of common wheats in large areas of North Dakota, South Dakota, and Minnesota amounted to 50–60 per. cent. of the crop. In the case of the durum wheats, the loss was 10 per cent. or less, generally 3–5 per cent.

Einkorn (*Triticum monococcum*) is also very rust-resistant. Some varieties of Emmer (*Triticum dicoccum*) are resistant, while others are susceptible. The Spelts (*Triticum Spelta*) are quite susceptible to rust attacks.

The second method, that of crossing susceptible and resistant varieties, has also been followed. The wilt disease already mentioned is extremely destructive to watermelons; the citron, however, is resistant. Orton [20] has obtained a hybrid between the watermelon and the citron which is resistant to the wilt. Unfortunately, however, the melons produced on the hybrid vines were not edible. The hybrid was again crossed with the watermelon and plants obtained, one-fourth citron and three-fourths watermelon, very resistant to wilt and also producing good, edible melons.

Attempts have been made to cross resistant varieties of cereals with non-resistant with a fair degree of success. Especially interesting are the results obtained recently by Biffen.[3, 4] He has attempted to show that Mendel's laws of inheritance apply to the transmission of disease-resistant qualities. In 1902 Rivet wheat (*Triticum turgidum*) and Red King (*Triticum vulgare*) were crossed. The former is relatively immune to the attacks of the yellow rust (*Puccinia Glumarum*), while the latter is very susceptible. The

hybrids from this cross all rusted very badly, like the parent Red King. However, 300 grains were secured, from which 260 plants were raised in 1903. The season was very favorable for rust. The plants were examined at the height of the rust attack. Sixty-four were found practically immune and one hundred and ninety-five rusted, most of them badly. The ratio of 64 to 195 is nearly 1 to 3. Taken in connection with the fact that the first generation was badly rusted, Biffen concluded that susceptibility and immunity are Mendelian characters, susceptibility being dominant. The results for the third generation confirm this view. An examination of four plots which contained both rusted and non-rusted plants, showed 149 rusted plants and 48 free from rust, a ratio of 3.1 to 1.

Biffen has also crossed American Club Wheat (*Triticum compactum*) and Michigan Bronze (*T. vulgare*). The former is relatively immune, while the latter is a susceptible variety. The hybrids of the first generation were badly rusted. The seed of these hybrids was planted and the following results were obtained:

Plant	5a	yielded	56	rust-free	individuals	and	147	rusted	individuals.
"	5b	"	45	"	"	"	"	153	"	"
"	5c	"	47	"	"	"	"	142	"	"
"	5d	"	36	"	"	"	"	154	"	"
"	5e	"	44	"	"	"	"	164	"	"
			228					760		

Plants 5f, 5g, 5h, and 5j, gave 295 rust-free plants and 849 rusted. The whole series gave 523 immune and 1,609 rusted, a ratio of 1 to 3.07.

It was observed that the severity of the rust varied on the different plants. From fifty heads of badly rusted plants, .8 gm. of seed was obtained; from fifty heads of moderately rusted plants 64 gm. of seed; and from fifty heads of immune plants, 145 gm. of seed were harvested.

Biffen tested also the inheritance of immunity to the attacks of *Erysiphe Graminis*. *Hordeum spontaneum* Koch and *H. hexastichofurcatum* K.H. were crossed, the former being the immune parent. The hybrid was attacked by mildew as badly as the susceptible parent. In the next generation 56 plants were badly mildewed, 16 slightly attacked, and 7 entirely free. At the same time, the parent *H. spontaneum* was very slightly mildewed, while the other parent was badly attacked.

Biffen concluded that liability to disease is the dominant character, the hybrids of the first generation being quite susceptible to the attacks of the fungus. In the second generation a portion of the hybrids proved practically immune; the remaining ones still proved susceptible to the disease. It is interesting to note that Orton, in his work with the watermelon wilt, found that the hybrid of the first generation was immune.

It must be remembered, of course, that the immunity which plants enjoy against a given fungus is relative, not absolute. Barley plants can be infected with the wheat mildew, if subjected to abnormal treatment. Salmon[26] has mechanically injured barley leaves, subjected them to anaesthetics, alcohol, or water heated to about 50° C., and inoculated them with conidia from wheat. Infection occurred on such treated leaves. Miss Gibson[14] has sown the spores of several rusts on hosts which they are not known to infect. She found that in nearly every case germ tubes were pushed out which passed through the stomata into the mesophyl of the leaf. The parasite may even attain a considerable development in a plant which it finally cannot fully infect.

Plants resistant to a particular fungus in one region may be quite susceptible to the same fungus if transferred to another locality. Butler[7] states that Farrer's hybrids, resistant to rust in Australia, show a marked liability to rust in India. Einkorn in general has been found extremely resistant to rust attacks. Howard,[16] however, reports that in India this same wheat succumbed to the attack of *Puccinia Graminis*, due, probably, to the hot season. The plants remained immune until the hot weather, although surrounded by other wheats infected with rust.

The above-mentioned facts indicate that the external conditions of the plant play a prominent part in determining whether it is immune or susceptible to a given fungus-disease. While immunity or susceptibility to disease may be transmitted from parent to offspring, the influence of external factors must also be taken into consideration.

The study of disease-resistant plants affords an extremely interesting field for investigation. As yet we do not know what immunity is. We are unable to state why Common Emmer is free from the attacks of mildew while the Black Winter Emmer

is susceptible, nor do we know to what extent immunity or susceptibility to a given disease can be transmitted from parent to offspring. The influence of external conditions, the factors of a plant's environment, is yet to be worked out. Further investigations with these resistant varieties and their hybrids should throw considerable light on this question.

I desire to express my appreciation of Professor R. A. Harper's and also Professor C. Stuart Gager's kindness in reading the manuscript of this paper and for many valuable suggestions.

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On the characters and relationships of the Platanaceae *

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(WITH PLATE 25)

Recent writers under the leadership of Niedenzu (1) in the Engler and Prantl Pflanzenfamilien have agreed in placing the Platanaceae in the Rosales between the Saxifragaceae and the Rosaceae. But as to the characters of the family, which of course form the basis of all deductions concerning its relationships, there is no agreement. This is very strikingly brought to notice by comparison of two leading floras recently published almost simultaneously. Robinson and Fernald in Gray's New Manual (2) state that the flowers are "destitute of calyx and corolla" while Gleason, (3) describing the Platanaceae in the North American Flora, attributes both calyx and corolla to the flowers.

Neither of these authors is to be held accountable for the statements in his description, for both are undoubtedly compilations from older authorities. Indeed, Robinson and Fernald's description is copied verbatim from Gray's fifth (4) and sixth editions published as long ago as 1867. But since the appearance of the Pflanzenfamilien in 1891, which figured and diagrammed the flowers as having both petals and sepals, almost all writers have credited the flowers with them and have described them, sometimes in considerable detail. Of these descriptions that of Sargent (5) will serve as an example. "Calyx of the staminate flower divided into 3–6 minute scale-like sepals slightly united at the base, about half as long as the 3–6 cuneiform sulcate, scarious pointed petals; stamens as many as the divisions of the calyx, opposite them, . . . ; calyx of the pistillate flower divided into 3–6, usually 4 rounded sepals much shorter than the acute petals; stamens scale-like, elongated-obovate, pilose at the apex; ovaries as many as the divisions of the calyx, superior. . . ." And in his Silva (6) he gives figures and floral diagrams showing these parts.

* Contributions from the Botanical Laboratory of the Ohio State University, No. XLVII.

In view of these contradictory statements it seemed desirable to undertake a study of the genus for the purpose of ascertaining the facts and of discussing its relationships. When the matter was first taken up in 1905, it was the intention to work out the whole life history of our common sycamore, *Platanus occidentalis* L. With this end in view frequent collections were made from October to August and serial sections cut after the usual methods. This intention was frustrated by a severe frost at anthesis, which so injured the flowers that only a small portion of them ripened seed. The effects of this injury were entirely internal, however, for the heads all developed alike so that it was not possible to discriminate between the good and the bad until the sections were made — too late to replace the material the same season, and other work has prevented my doing so in succeeding years. The gaps in the life history are so great on this account that it has seemed advisable to publish only the observations on the morphology of the flower, which perhaps bears more directly on the relationships of the group. I here desire to express my thanks to my colleague, Professor John H. Schaffner, for much advice and criticism.

The head consists of a cluster of flowers so much shortened that the individual pedicels are hard to distinguish. At first sight, even under a microscope, the staminate head in section looks like a single receptacle the whole surface of which is indiscriminately covered with stamens much after the fashion of a staminate cone of *Pinus*, a similarity which is heightened by the resemblance of the stamens of the two, because of the enlarged leaf-like blade of the connective (FIG. 2). Closer scrutiny of a median section (FIG. 1), however, shows narrow furrows slightly deeper than the general surface of the head, which separate the stamens into groups of one or two (as seen in the section). These furrows are the intervals between the greatly shortened and crowded pedicels which cover the head. This is made more evident by the examination of a tangential section (FIG. 4). Each peduncle, which bears three or four stamens, is surrounded by a circular scale (*sc*, FIGS. 1, 2, 4), which tapers upward into a fringe of hairs. This is so minute and insignificant that it might easily be overlooked in the abundant hair of the head; it has no vascular supply and is only two cells in thickness; it develops early and

before flowering time its cells are dead, leaving it simply a hairy fringe. Beyond these scales the staminate flowers are entirely naked until long after the stamens are completely formed. When growth is resumed after the winter, however, the receptacle, which has remained flat up to that time, begins to swell and forms bulging protuberances between the filaments (FIG. 2, *O*). In cross-section (FIG. 3) these are seen to be alternate with the stamens. They are the structures which have been called vestigial carpels.

Sections of the carpellate head (FIGS. 5–7) show an exactly similar condition. The shortened closely crowded peduncles are surrounded by vestigial sheathing bracts. The folded carpels, usually 6–9 in number, are located rather indiscriminately over the upper surface of the receptacle but with their inner open sides facing the center (FIG. 6). Beside these the only other floral parts present are three or four hairy staminodes (*s*, FIGS. 5–7), which fold over the carpels and protect them until just before anthesis. While the homology of the outgrowths from the receptacle of the staminate flower to carpels is somewhat uncertain because of their rudimentary condition, there is little doubt that these appendages of the carpellate flower are homologous with stamens. They develop before the carpels, have a strong vascular supply, and are even sometimes quadrilateral.

Such being the condition of the flowers, one turns with wonder to the accounts of those authors who give not only descriptions but figures of the petals and sepals. As has been said the account in the Pflanzenfamilien is the source of all the later descriptions. But this is itself a compilation from the work of Schoenland (7), from which its figures are copied. Schoenland describes the perianth very circumstantially and in considerable detail. According to him, I translate (p. 310): "The flowers are perigynous; they possess always two regular, alternating, characteristically different circles of involucral leaves each part of which may however show considerable variation. I have no hesitation therefore in designating the outer as calyx and the inner as corolla. . . . These circles are 3–6-parted (perhaps also to 8-parted). The numerical relations may vary in one and the same inflorescence. In the staminate flowers the 4-parted condition is most frequent." He figures a tetramerous pistillate flower with sepals, petals, stami-

nodes, and carpels in regular circles, the parts of which alternate with each other. In this figure the divisions of the corolla are about half as long as the carpels — so large that they could scarcely be overlooked on examination even with a hand lens. He supplies diagrams also, showing trimerous, tetramerous, and hexamerous flowers with the parts equidistant in regular circles.

Only a few stages, however, are favorable for study. He says (p. 309): "The best time for the study of the completely developed flower is when the anthers have just begun to shed their pollen. Before this period the investigation is enormously difficult; afterwards the staminate flowers dry up and become unfavorable for investigation; likewise the pistillate flowers shed a part of their organs very quickly after anthesis. In fruit a strong growth of hair very similar to the pappus of the Compositae develops around the carpels, so that it is no wonder that even eminent botanists have stated that the perigynium of the Platanaceae is reduced to hair-like scales between the separate flowers, which represent the floral parts." But even at this favorable period he was able to find no constancy in the regular cycles he figures. On this point he says (p. 311): "In the case cited above where the different organs of the flower occur in like number the confirmation of the diagrams, empirically obtained, was more or less easy. But on account of the crowding of the flowers all possible cases of displacement, suppression, and stunting of the organs are brought about, so that in many flowers one can determine absolutely nothing with certainty regarding the spacial relations of the parts."

Schoenland did his work only a few years after the appearance of Eichler's Blütendiagramen, when the influence of Eichler's school was at its height. This school had already pushed the method of studying flowers by means of the comparison of floral diagrams to great extremes. Their method had proved so useful that it was supposed that the flowers of all plants must be referable in some way or other to such regular schemes. Under the influence of this school Schoenland seems to have labored principally to verify a diagram representing the cycles which he supposed ought to be present. In this deductive method of reasoning he was prevented from checking his results by the facts because of his

supposition of a deciduous perianth and of modifications due to pressure, factors which though potent in many cases cannot be invoked to explain the flowers of *Platanus*.

Moreover, because of the hairiness and the early lignification of the inflorescence the sycamore is an exceedingly difficult object to handle even by the best methods of modern technique, which had not been invented at the time of Schoenland's work. He himself recognized very clearly the insufficiency of his methods, concerning which he says (p. 313): "A complete isolation of the individual young flowers is possible and was accomplished by me in different ways; but the advantages obtained thereby are very doubtful, since, because of the density of the inflorescence, parts of the preparations are easily torn off, which naturally introduces numerous errors.

"I have preferred therefore for the most part to cut thin sections from heads hardened in alcohol, and to observe them in glycerine by reflected and transmitted light. The thick pubescence of the bud-scales and of the sepals is extremely disturbing, so that for the most part one can determine in this way nothing certain regarding the sepals or the petals which they cover, especially since there occur, irregularly distributed between the individual flowers, rather long hairs which are entirely distinct from the pappus-like hairs of the fruit. In the staminate or apparently perfect flowers this method is of no service, since here the thick pubescence of the anthers or staminodes makes every observation impossible. In these I was limited to longitudinal sections of the flowers, and although I am aware that one can use results which are obtained in such a way only very cautiously, on account of the impossibility of orienting the sections satisfactorily, yet I believe that I have reached correct conclusions from them, since they are in perfect accord with the facts otherwise determined." We must admire the perseverance of a man who was willing to attempt scientific work under such difficulties but we cannot give much weight to his results.

It is apparently safe to assume that the inflorescence of *Platanus* has attained its present very compact condition by the shortening of the pedicels of the individual flowers. To what extent this shortening has involved loss of floral parts is a matter

of conjecture. Such shortening might be expected to favor the development of perigyny but the flowers are clearly hypogynous (FIGS. 1, 2, 5) and have no perigynous disc as Schoenland maintains. The presence of staminodes and of rudimentary carpels seems to indicate clearly that the flowers were originally perfect. The homology of the scale encircling the pedicel is somewhat doubtful. It may be the vestige of the calyx. But its form suggests strongly the sheathing base of a foliage leaf. If it is to be compared with a leaf it would represent a vestigial bract surrounding the pedicel as the bases of the leaves surround the buds in their axils. But it is so much reduced that it is not possible in my judgment to determine with certainty what it represents.

Whether this represents a bract or a calyx, it is clear that *Platanus* is apetalous and that it should be removed from the Rosales and placed among the Apetalae. In this group the place of the Platanales is probably to be found next the Urticales. This position they originally held on account of their obvious resemblances to some of the Urticales. There seem to be in this case no characters of the life history which are more significant than those general similarities that every observer recognizes, namely: the tendency toward the aggregation of the flowers into spherical heads by the shortening of the pedicels, which has been carried to its culmination in *Platanus* and such genera of the Urticales as *Artocarpus* and *Toxylon*, and the development of sheathing stipules completely encircling the stem and covering the bud as in *Artocarpus* and *Ficus*. Between these genera and *Platanus* there is of course a gap so wide as to be of ordinal rank, and yet these similarities may indicate the approximate place of the Platanales among the orders of the Apetalae and save it from complete isolation.

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Explanation of plate 25

The figures are camera drawings of microtome sections. *c*, carpel; *o*, outgrowth from receptacle of staminate flower = vestigial carpel; *s*, staminode; *sc*, encircling scale; *st*, stamen.

FIG. 1. Portion of a median section of a staminate head, showing one flower with parts of two others at the sides, × 65. October 3.

FIG. 2. Longitudinal section of a staminate flower, showing outgrowths from the receptacle, which are doubtfully homologized with carpels, × 25. April 25.

FIG. 3. Cross section through the filaments of a flower of the same age as fig. 2, × 65.

FIG. 4. Tangential section through the pedicels of a staminate inflorescence of same age as figs. 2 and 3, × 65.

FIG. 5. Longitudinal section of a group of carpellate flowers, × 25. January 15.

FIG. 6. Tangential section of a carpellate head, × 65. April 18.

FIG. 7. Similar section at the level of the encircling scale, × 65. April 18.

Notes on Rosaceae — II

Per Axel Rydberg

Schizonotus

In Harms' list of Genera Conservanda, adopted by the Vienna Botanical Congress, the name *Sorbaria* A. Br. of 1864 is given among those which should be retained, and it is preferred to the older *Basilima* Raf. 1836 [should have been 1838] and the still older *Schizonotus* Lindl. of 1829. Usually the publication of the last-named genus is accredited to Wallich's Catalogue.* This catalogue, however, was not published in the sense the word "published" is usually taken, for it was merely a duplicated collector's list. Besides, *Schizonotus* is there merely a *nomen nudum, i. e.*, being accompanied neither by a description nor by a synonym cited. In Lindley's Introduction to the Natural System of 1830, *Schizonotus* is really published, as Lindley points out the characteristic fruit of *Spiraea sorbifolia* and proposes the name *Schizonotus* on page 81, and on page 83 enumerates *Schizonotus* as a genus recognized by him. The combination *Schizonotus sorbifolius* was not actually published until eleven years later in the second edition of Steudel's Nomenclator.

Is there any good reason for preserving *Sorbaria* instead of either of the two older names? If there had been a rule providing that when a subgenus, or section of a genus, is raised to generic rank, then the subgeneric or sectional name should be retained, *Sorbaria* A. Br. would have had a standing, for as a name of a section of *Spiraea* it dates from 1825. Such a rule has been advocated to some extent in this country, but the Vienna Rules do not provide for anything like it. *Sorbaria* apparently was selected purely arbitrarily, perhaps because it had been adopted by Focke in Die Natürlichen Pflanzenfamilien. If *Sorbaria* had been a generally accepted genus, there might have been also some reason for its retention, but this is not the case. Scarcely any one has used

* No. 703. 1829.

it from its publication until it was used in the Pflanzenfamilien. If the choice had been only between *Sorbaria* and *Basilima* there might have been another reason why the former should be preferred; the latter was proposed by the erratic Rafinesque, who did things only by halves. But *Schizonotus* was proposed by Lindley, one of England's most prominent botanists. Perhaps the fact that Rafinesque applied the name *Schizonotus* to a different genus had something to do with it; but Rafinesque never intended to name a new genus *Schizonotus*, when he used it as generic name for *Spiraea discolor* Pursh. He simply thought that he was using it in the same sense as Lindley. It was simply a matter of wrong identification.

CHAMAEBATIARIA

This genus has been supposed to be monotypic. There exists, however, a second species, although it seems to be very rare and of a rather restricted distribution. *C. Millefolium* resembles the genus *Chamaebatia* in general habit and has often been mistaken for it, but this likeness is still greater in *Chamaebatiaria glutinosa*. Even to a trained botanist, who knows both, it would be hard, without flowers or fruit, to distinguish the latter from *Chamaebatia foliolosa*. The oldest specimen known of *C. glutinosa*, viz., its type, was sent to Dr. John Torrey, who wrote the following remarks on the sheet: "Given to me by Dr. Bolander, in San Francisco, Sept., 1872. The only specimen he had ever seen. We both supposed it might be a n. sp. of *Chamaebatia*, but it proves to be a *Spiraea*, nearly allied to my *S. Millefolium*. 4–5 feet high."

Besides the type, only the following specimens have been seen by the writer:

CALIFORNIA: 1855, *Newberry*.
NEVADA: *Ward*; 1885, *Mrs. Clements*.

PORTERANTHUS

This genus was first published under the name of *Gillenia* Moench in 1802. There is, however, an older *Gillena* Adans.* named for the same person and properly published, as it was based on *Volkameria* P. Br.† and *Tinus* L.‡

* Fam. Pl. 2: 166. 1763.
† Hist. Jam. 214. 1756.
‡ Syst. 1010. 1759. [Ed. 10.]

LINDLEYELLA

This genus has been known as *Lindleya* H.B.K. (1823). But the name *Lindleya* had been used twice before, viz., in 1821–2 by Kunth* and by Nees.† The former is supposed to be a synonym of *Casearia* Jacq. and the latter of *Laplacea* H.B.K.,‡ published the same year. Which of the two was first published can scarcely be decided, and *Lindleya* Nees may replace *Laplacea* H.B.K. Following the rule, "Once a synonym, always a synonym," the writer was forced to propose a new name.

That the genus contains more than one species is evident. If anyone compares the illustrations cited in the North American Flora under *L. mespiloides* with those in the Botanical Register and the Fleurs des Serres, cited under *L. Schiedeana*, he will see that they can scarcely represent the same plant. *L. mespiloides* has been described as a very variable plant, perhaps partly on account of these very unlike illustrations. There are perhaps more than two species included, but the author has no evidence that proves the existence of more than two. All the specimens found in the herbaria of the New York Botanical Garden, Harvard University, and the United States National Museum, except one, agree fairly well with the original illustration in Humboldt, Bonpland & Kunth's Nova Genera et Species. The only exception is Schiede's plant and this agrees fairly well with the illustrations in the Botanical Register and in the Fleurs des Serres.

VAUQUELINIA

When the author began the revision of this genus, he had two species at hand, which had been named *V. corymbosa*, but the first glance at the original illustration of the latter showed him that neither of the two could belong to it. One of these was referred to *V. corymbosa* by Torrey in the Botany of the Mexican Boundary Survey. This error was corrected by Watson, who renamed the plant *V. Torreyi*. The plant had been collected earlier, however, during Emory's Reconnoissance and had been described by Torrey as *Spiraea californica*. For this reason the

* Malv. 10. 1822.

† Flora 4: 299. 1821.

‡ H.B.K. Nov. Gen. et Sp. 5: 207. 1821.

name was changed to *V. californica* by Sargent, although the plant is not found within the state of California. *Spiraea californica* differs, however, somewhat from *Vauquelinia corymbosa* of the Mexican Boundary Survey, having broader and less tomentose leaves. Whether the two forms represent two distinct species or not is hard to tell, as the author has seen but one specimen resembling the type of the former, and both this specimen and the type are but fragmentary.

The other plant, named *V. corymbosa*, is a shrub from Chihuahua and best represented by Pringle's *no. 5*. This is characterized by its narrow leaves and has therefore received the name *V. angustifolia*. It is represented by the following specimens:

MEXICO: Santa Eulalia Mountains, state of Chihuahua, 27 May, 1885, *C. G. Pringle 5* (flowers); 14 Aug., 1885, *Pringle 369* (fruit); 1885, *E. Wilkinson* (flowers).

As stated before, neither of these could be referred to *V. corymbosa* Correa. Neither could they be referred to *V. Karwinskyi* Maxim. Of the latter I had seen no specimen, but Maximowicz's description was ample enough to determine this fact. The author therefore made a key and drew the description of the four species as well as he could from the herbarium material of two of them and the descriptions of the two others. While the monograph was in press some material was received from Washington, and in this material were found specimens of the two missing species. There was, however, only little to be added or modified in the descriptions. *V. corymbosa* is represented by the following specimens:

MEXICO: Ixmiquilpan, Hidalgo, Aug., 1905, *C. A. Purpus 1384*.

V. Karwinskyi by the following:

MEXICO: Alvarey, San Luis Potosi, May 19–22, 1905, *E. Palmer 594;* perhaps also, San Lorenzo Cañon, six miles southeast of Saltillo, Coahuila, April 16, 1905, *E. Palmer 538*.

SERICOTHECA

According to the Vienna Rules and Harms' list, *Holodiscus* Maxim. should be retained in preference to *Schizonotus* Raf. If there were any regard to priority, such a provision would be unnecessary, for *Schizonotus* Raf. (1838) is a homonym of the older

Schizonotus Lindl. (1830). But why should not *Sericotheca* Raf. (1838) be considered? It was just as well published as was *Schizonotus*, and was published by the same author. It is another illustration of how poorly digested and how incomplete Harms' list is. The present writer would perhaps be willing to subscribe to a list of *nomina conservanda*, provided that a good reason in each case could be given; but a list which arbitrarily retains or rejects genera published under similar conditions by Hill or Adanson, as shown by Druce in his introduction to his List of British Plants, has no standing with the present writer.

The genus *Sericotheca* is a very perplexing one, and it is very hard to draw lines between the species. Otto Kuntze reduced the whole genus to one species. Every one must admit that by so doing he went too far. The genus can be divided into two types; one with the teeth of the leaves rounded or rounded-ovate, ending in a short mucro, and achenes straight on the back; the other with the teeth lanceolate or triangular-ovate, ending in a long mucro, and the achenes more or less curved on the back. The two species would then be *S. discolor* and *S. argentea*. This would be the ultra-conservative view. Both species, especially the former, would, however, show such a diversity of forms that a number of varieties would have to be admitted. If S. *discolor* is compared with *S. microphylla* or *S. glabrescens*, few botanists would regard them as the same species. It is only when the other members of the genus are known and considered, that some would regard them as varieties of one species. C. K. Schneider, who can very well be credited to the conservative school, has been forced to admit four species. He made the statement that he could not see any difference between *Holodiscus microphyllus* and *H. dumosus* but I think this was due to the fact that he followed S. Watson in his interpretation of *H. dumosus*. Watson's idea of *H. dumosus* was an aggregate of those species which have a narrow and rather simple inflorescence, *i. e.*, *Sericotheca concolor*, *S. microphylla*, and *S. glabrescens*. *S. Boursieri* and *S. saxicola* would also have been included, had they been known to Watson. Now, the fact is that the original *Spiraea dumosa* Nutt. cannot be distinguished specifically from *Holodiscus australis* Heller. The latter Schneider admits as a good species. It is true that *Spiraea*

dumosa Nutt. and *Holodiscus australis* Heller are not exactly alike. The former represents the extreme hairy form with more than usually double-toothed leaves and the latter the more glabrate extreme with simpler teeth.

It was with some reluctance that the writer proposed his new species *S. franciscana*, not because the type is not amply distinct from *S. discolor*, but because there are forms that connect the two. The former is characterized by its thick, dark green leaves, densely short-hairy, almost velvety above; the latter by its thin leaves, glabrous or almost so above. The following specimens are to be referred to *S. franciscana*:

CALIFORNIA: Monterey, on the Mexican Boundary Survey, 1850, *C. C. Parry*; Southern Upper California, *Fitch 2* and *3*; Sonoma (Whipple's Exploration), *Bigelow 4*; Pilarcitos, Sept., 1867, *N. J. Davis 48*; San Leandro, June, 1888, *Underwood* (type); Albion Ridge, Mendocino County, June, 1903, *J. McMurphy 266*; Crystal Spring Lake, June, 1903, *Elmer 4274*; [no locality], *Thomas Bridges 100(a)*; 1868–'9, *Kellogg & Harford 201*; Crystal Spring Lake, Sept. 2, 1902, *Baker 1552*; Ukiah, Mendocino County, July 11, 1902, *Heller*; Duncan's Mills, July 18, 1882, *M. E. Jones 3579*; Santa Lucia Mountains, June, 1898, *R. A. Plaskett 161*; Mendocino, June, 1898, *H. E. Brown 805*; Coast Hills, San Luis Obispo County, May, 1885, *Mrs. Summers 95*.

S. pachydisca Rydb. of Mexico is intermediate between *S. discolor* and *S. dumosa* in leaf-form, but differs from both in the much more developed disk in the mouth of the hypanthium. This may be the same as *Schizonotus argenteus intermedius* O. Kuntze, but Kuntze's description is too incomplete.

It is strange that *Spiraea Boursieri* Carr. has not been recognized, notwithstanding the excellent figure published in the Revue Horticole.* The few specimens in existence in our herbaria have been included in *S. dumosa*, as interpreted by S. Watson, perhaps on account of its small and simple inflorescence. *S. Boursieri* differs, however, from *S. microphylla* and *S. concolor* in the shape of the leaves and the much larger flowers. It has the largest flowers of all the United States species known. To it may be referred:

* **1859**: *f. 108.*

CALIFORNIA: Yosemite Valley, 1872, *J. Torrey; Thomas Bridges 100.*

NEVADA: Clear Creek Cañon, Ormsby County, Aug. 6, 1902, *Baker 1431.*

To *S. concolor* are referred, besides the type:

CALIFORNIA: Long Meadow, Tulare County, June 7–14, 1888, *Edward Palmer 187;* Mt. San Antonio, July, 1901, *Le Roy Abrams 1917;* Coyote Creek, July 30, 1904, *Culbertson* [Baker's distribution no.] *4332.*

NEVADA: Western Nevada, 1865, *Stretch;* Pine Forest Mountains, July, 1901, *Griffiths & Morris 196.*

To *S. Schaffneri* are referred the following:

MEXICO: San Luis Potosi, 1879, *Schaffner 451; Parry & Palmer 223.*

ARIZONA: Bill Williams Mountains, June, 1883, *H. H. Rusby 588.*

S. obovata is closely related to *S. glabrescens*, but differs in the larger leaves, which are densely villous-pubescent above. It resembles also *S. dumosa* but its leaves are decidedly glandular-atomiferous. The following specimens are referred to it:

CALIFORNIA: Woods on Truckee River, July 17, 1886, *Sonne* (type); Bear Valley, Calaveras County, Aug. 23, 1892, *Geo. Hansen 234.*

Spiraea fissa Lindl. has been improperly understood. By the courtesy of the Director of the Kew Gardens, the New York Botanical Garden has received a fine tracing of the type and also some fragments. Kuntze's type of *Schizonotus argenteus alpestris* is now in the herbarium of the N. Y. Botanical Garden and there is also a duplicate of *Holodiscus argenteus bifrons* Focke. The former is merely a reduced form and the latter a rather luxuriant one of *S. fissa.* Neither deserves even a varietal rank. Kuntze recognized also a var. *fissus*, based on *Spiraea fissa* Lindl. Although he placed the two varieties in different divisions of the key, they can not be separated. The key is not workable, and as he cites no specimens, some of his varieties will remain unknown. The var. *alpestris* is the only one represented in his herbarium.

S. velutina is a closely related species, which has been confused with it and with *S. argentea.* It has the habit of *S. fissa*,

but has more hairy leaves and fruit like that of *S. argentea*. It may be *Schizonotus argenteus mexicanus* O. Kuntze, but it is scarcely *Spiraea mexicana* Schiede. I refer to it the following specimens:

MEXICO: Sierra de San Filipe, Oaxaca, Sept. 25, 1894, *Charles L. Smith 821*; 1894, *E. W. Nelson 1085*; 1894, *Pringle 5734*.

FILIPENDULA

As represented in North America, this genus could very well be divided into 4 genera, viz.:

1. ULMARIA Hill, with *F. Ulmaria* and *F. denudata*.
2. FILIPENDULA Adans., with *F. Filipendula*.
3. THECANISIA Raf., with *F. rubra*.
4. [Unnamed], with *F. kamtschatica* and *F. occidentalis*.

Several of the Asiatic species, however, combine the characters of two or more of these genera and the generic lines disappear altogether. It was therefore deemed advisable to keep them as a single genus.

HORKELIA

Three species of this genus had been published since my Monograph of the North American Potentilleae.* These are: *H. glandulosa* Eastwood, *H. Wilderae* Parish, and *H. Rydbergii* Elmer. All of these are known from the type localities only. Six were proposed as new in the North American Flora, viz.: *H. truncata*, *H. Brownii*, *H. tenuisecta*, *H. integrifolia*, *H. pulchra*, and *H. hispidula*. Of these *H. truncata* and *H. tenuisecta* were partly known to the writer when his monograph was prepared, but were there included in other species. Two sheets of the former were included in *H. platycalyx* which it resembles in floral structure. These specimens were:

LOWER CALIFORNIA: Guadalupe Mountains, 1883, *C. R. Orcutt 840* (labeled *Horkelia californica paucifoliata* Wats.).

They were not very good specimens and therefore not so critically studied. Better specimens have been seen since. The best of these is in the herbarium of the University of California. Although the specimen was from a cultivated plant, it was designated as the type.

* Mem. Dep. Bot. Columbia Univ. 2: 1898.

H. tenuisecta was better known, but the author mistook it for *H. tenella* (*H. fusca tenella* S. Wats.). A reexamination of the type of the latter proved it to belong to a species which the writer thought undescribed. *H. tenuisecta* is therefore the same as *H. tenella*, in greater part, of the writer's monograph. To it belong the following specimens:

WASHINGTON: Falcon Valley, July 28, 1882, *Suksdorf 2492* (type), and 1896, *60*; Ice Cave, Trout Lake, Aug. 5, 1894, *F. E. Lloyd*.

To the true *H. tenella* belong the following:

CALIFORNIA: San Joaquin River, Fresno Co., 1891, *Coville & Funston 1836*; Hogg Ranch, Yosemite National Park, 1902, *Hall & Babcock 3378*; Morgan, Tehama Co., 1903, *4392*; Cannell Meadows, Tulare Co., 1904, *5117*.

Horkelia hispidula is related to *H. sericata* but lacks the silvery pubescence characteristic of that species. In habit it resembles *H. Micheneri* also and may easily be mistaken for it, if the floral characters are overlooked, the sepals and bractlets being very different. *H. hispidula* is known only from the type locality.

H. Brownii is related to *H. tenella* and *H. parviflora*. It differs from the former in the dense pubescence and from the latter in the deeply divided leaflets and the open inflorescence. To it is to be referred the following specimen, besides the type:

CALIFORNIA: Mt. Shasta, 1892, *E. Palmer 2448a*.

H. integrifolia is related to *H. tridentata* but differs in the entire leaflets and the appressed pubescence of the stem and the petioles. It is known only from the type locality.

H. pulchra is related to *H. congesta* but the leaflets are 13–17 instead of about 9 and they are deeply cleft into lanceolate divisions. It also is known only from the type station.

One change of name was necessary. *H. bernardina* Rydb. was substituted for *H. Parryi* Rydb., there being an older *H. Parryi* Greene. *H. Parryi* Rydb. was based on *H. Bolanderi Parryi* S. Wats. It may be that Dr. Greene had the latter in mind, when he proposed the new species, but there is no evidence that he did, for he cited no synonym, nor in any other way referred to Watson's variety. The types of both *H. Bolanderi Parryi* S. Wats. and *H. Parryi* Greene were collected by Parry in southern California, but at different localities and in different years.

HORKELIELLA

The writer thought it advisable to raise the subgenus *Horkeliella* of *Horkelia* to generic rank. Even if the characters separating it from *Horkelia* and *Ivesia* are not very prominent ones, the writer's opinion is that the arrangement here adopted will make the treatment of the tribe much clearer. To the two species included in the subgenus is to be added a third one, *Horkelia Congdonis*.

IVESIA

The writer restored this genus in the North American Flora, after having included it in *Horkelia* in his Monograph of the North American Potentilleae. In the latter publication he reduced it, simply because one species, *I. argyrocoma*, has more or less dilated filaments. The species is in every other respect as good a species of *Ivesia* as any of the *I. unguiculata* group. The type species of the genus, *I. Gordonii*, has but 5 stamens and a more scape-like stem, but the structure of the flower and the general habit are otherwise practically the same. In *I. pygmaea*, *I. Shockleyi*, *I. setosa*, and *S. Baileyi*, the hypanthium is much flatter than usual in the genus; it has a distinct thickening or disk in the throat, and the filaments are short, inclined towards the center of the flower, thus approaching the structure of the flowers of the genus *Comarella*. These species (except sometimes the last one) have leaves with spinulose-tipped teeth or lobes, and only 5 stamens. It is not advisable to remove these species from *Ivesia*, however, for at least the first two have otherwise the habit of *I. Gordonii* and other 5-stamened species of the *I. lycopodioides* group; and another species, *I. chaetophora* Rydb., has the same habit and the same spinulose-tipped teeth or divisions, but a more campanulated hypanthium, no thickened disk, and 10 stamens.

The species of the *I. eremica* group approach the genus *Potentilla* in the almost clawless petals and the less developed hypanthium, but otherwise they are typical Ivesias.

The following species were proposed as new: *I. Tweedyi*, *I. megalopetala*, and *I. setosa*.

The first one was included in *Horkelia utahensis* in my Monograph; the other two were there treated as varieties of *H. Gordonii* and *H. Baileyi*, respectively.

To *I. Tweedyi* belong, besides the type, the following specimens:

WASHINGTON: Cascade Mountains, 1882, *T. S. Brandegee.*

I. callida (Hall) Rydb. was transferred from *Potentilla*, and placed in the *I. eremica* group, although not so closely related to the other members.

PURPUSIA

P. saxosa is still unknown except from the type locality. Other specimens have been referred to this species, as for instance, *Heller 8297*, but this belongs to *Potentilla acuminata* Hall; some others belong to *Potentilla saxosa* Lemmon. *Ivesia Baileyi* may also be mistaken for it. The few pistils on a stalked receptacle and the absence of bractlets distinguish it at a glance from all three.

COMARELLA AND STELLARIOPSIS

These two genera were treated as in my monograph.

NEW YORK BOTANICAL GARDEN.

What is Convallaria odorata Mill.?

G. Claridge Druce

In the Annals of Scottish Nat. Hist. 226. 1906, I suggested that the plant described by Miller in the Gardener's Dictionary Ed. 8, no. 3, 1768, is the *Convallaria Polygonatum* L. Mr. James Britten, however, dogmatically asserted that Miller's specimen representing this species in the National Herbarium at South Kensington is a form of *Polygonatum multiflorum*. As there was doubt about the identity, I unfortunately chose *P. Sigillum* (Lepech.) to represent *Convallaria Polygonatum*, since British botanists have not accepted *Polygonatum Polygonatum*, the more logical combination.

The evidence, however, apart from the herbarium specimen, about the identity, of which more anon, in favor of Miller's plant being *C. Polygonatum* L. is very strong.

Gerarde (Herball 758. 1597) first records it as British and he calls it Sweete smelling Salomon's Seale: the Polygonatum 1 [*sic*] Clusii. That sort of Salomon's Seale with broad leaves groweth in certaine woods in Yorkshire called Clapdale woods. Johnson (Gerarde Emac. 904. 1633) corrects the reference to Polygonatum 2 Clusii and replaces the poor figure by an unmistakable plate of *C. Polygonatum* L. Ray (Syn. 1690) calls it the 'Sweet Smelling Solomon's Seal' and he does so also in his Historia (1: 665. 1688), where he says "flores . . . verum majores et odore (qui in vulgari nullus est)." Linnaeus (Sp. Pl. 451. 1762) under *C. Polygonatum* quotes Bauhin (Pinax 303) for *Polygonatum latifolium, flore majore odoro.* Hudson (Flora Anglica 146. 1762) gives the same reference and adds "Sweet Lily-Convally or Solomon's Seal." So that in Britain till the time of Miller the Sweet-Smelling Solomon's Seal was the name given to the plant with larger flowers, and angular stem — the *C. Polygonatum* L. Therefore the presumptive evidence of Miller's *C. odorata* being identical was very strong. His description in the Dictionary confirms

this — *C. odorata*, Broad-leaved Solomon's Seal with a larger sweet flower.

Recently I have examined Miller's authentic specimen in the National Herbarium and to my great surprise find that Mr. Britten has made a serious error in naming it *P. multiflorum*. The specimen, which has the angular stems, the large flowers and glabrous filaments, is unmistakably *Convallaria Polygonatum* L., *Polygonatum officinale* All.

To those who follow the Vienna Rules, which claim priority for the earliest specific name except when it involves the duplication of a name, the name I first suggested has priority, *i. e.*, *Polygonatum odoratum* (Miller) Druce.

An attempt has been made to supersede *Polygonatum* Adans. by *Salomonia* Heister ex Fabric. Enum. Pl. Hort. Helmstad., Ed. 2. 38. 1763; indeed this is given in large type in the third Supplement to the Index Kewensis 158, but there is no need for this since *Polygonatum* dates not from Adanson 1763 (Fam. des Plantes) but from Hill 1756 (British Herbal).

OXFORD, ENGLAND.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1909)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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